Volume 22, Number 5, March 15, 1968

NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

FOURRIER, Alain
Radioactive chain of mass number 189, **21:10023**

Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

MONTH, M.
Theory of gradient perturbations in AGS, 21:9872 (BNL-10899)
MONTH, Melvin
Simple relativistic calculation of the electromagnetic form factors of the deuteron, 21:9744

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

SHEEP
radiation dosimetry in, measurement of lethal dose of x, 21:8905(R) (AD-631189)
radiosensitivity of hematopoietic system of, x, 21:8905(R) (AD-631189)

SHELTERS
construction of, for civil defense, 21:8838
design of fallout, 21:8777(R) (AD-629736)
design of shaft closure for, 21:8563(P)
determination of configuration of, for ventilation, 21:8779(R) (AD-629928)
equipment for fallout, minimal requirements of, 21:8782(R) (AD-631424)
evaluation of fallout, for fire and air blast damage, 21:8560 (URS-658-3)
fire resistance of components of, evaluation of, 21:8789(R) (AD-642241)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

UNION CARBIDE CORP., OAK RIDGE, TENN. Y-12 PLANT.
Mixing and sampling enriched ^{235}U fluids in cylindrical storage containers, 21:8500 (Y-1561)

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TID-		
3311(Suppl. 2)	21-8567	Dep. mn. CFSTI $3.00 cy, $0.65 mn
22298	21-9915	Nucl. News, 9: No. 12, 17-21 (Dec. 1966)
22298	21-9914	Nucl. News, 10: No. 1, 17-20(Jan. 1967)
23267	21-9702	Phys. Rev., 152: 1171-82(Dec. 23, 1966)
23287	21-8498	Dep. mn. CFSTI $3.00 cy, $0.65 mn
23420	21-8764	Lancet, 2: 672-5(Sept. 24, 1966)
23474	21-8528	Dep. mn. CFSTI $3.00 cy, $0.65 mn
23478	21-8641	Dep. mn. CFSTI $3.00 cy, $0.65 mn
23482	21-9471	Dep. mn. CFSTI $3.00 cy, $0.65 mn

TABLE OF CONTENTS

Volume 22, Number 5, March 15, 1968

Category *Page*

CHEMISTRY 805
- Analytical Chemistry 805
- Inorganic, Organic, and Physical Chemistry 810
- Radiation and Nuclear Chemistry 814
- Separation Processes 821

EARTH SCIENCES 826
- Geology and Hydrology 826
- Meteorology 827
- Mineralogy and Exploration 828
- Oceanography 828
- Seismology 829

ENGINEERING 830
- Nuclear Explosions 830
- Facilities and Equipment 831
- Heat Transfer and Fluid Flow 835
- Isotope Technology 836
- Materials Testing 838
- Radioactive Material Handling 839
- Vacuum Engineering 839

INSTRUMENTATION 840
- Radiation Detection Instruments 840
  - *General Detectors and Monitors* 840
  - *Nuclear Spectroscopic Instrumentation* 842
  - *High Energy Physics Instrumentation* 844
- Radiation Dosimeters 845
- Radiometric Instruments 846
- Miscellaneous Instruments and Components 846
- Radiation Effects on Instruments and Instrument Components 848

LIFE SCIENCES 849
- Biochemistry, Physiology, and Molecular Biology 849
- Ecology 857
- Genetics and Cytogenetics 857
- Health Physics and Safety 859
- Medicine 865
- Radiation Effects on Animals 869
- Radiation Effects on Plants 877
- Radiation Effects on Microorganisms 878
- Radiosterilization and Radiopreservation 879

METALS, CERAMICS, AND OTHER MATERIALS 883
- Metals and Alloys 883
  - *Corrosion and Erosion* 883
  - *Preparation and Fabrication* 885
  - *Properties Evaluations* 887
  - *Structure and Phase Studies* 892
  - *Radiation Effects* 894
- Ceramics and Cermets 896
  - *Preparation and Fabrication* 896
  - *Properties Evaluations* 897
  - *Structure and Phase Studies* 900
  - *Radiation Effects* 900
- Plastics and Other Materials 901

PHYSICS (GENERAL) 902
- Astrophysics and Cosmology 902
- Atomic and Molecular Physics 914
- Cosmic Radiation 924
- Direct Energy Conversion 926
- Fluid Physics 927
- Geophysics 931
- Low-Temperature Physics 936

PHYSICS (GENERAL) *cont'd.*
- Plasma and Thermonuclear Physics 940
  - *Confinement and Heating of Plasma* 940
  - *Diagnostics of Plasma* 941
  - *Kinetics of Plasma* 943
  - *Production of Plasma* 951
  - *Stability of Plasma* 953
  - *Thermonuclear Processes* 954
- Shielding 954
- Solid-State Physics 955
- Theoretical Physics 962

PHYSICS (HIGH ENERGY) 963
- Particle Interactions and Properties (Experimental) 963
  - *Electromagnetic* 963
  - *Weak* 963
  - *Strong (Baryon-Induced)* 964
  - *Strong (Meson-Induced)* 964
- Particle Interactions and Properties (Theoretical) 965
  - *General* 965
  - *Electromagnetic* 966
  - *Weak* 968
  - *Strong (General)* 969
  - *Strong (Baryon No. = 0)* 970
  - *Strong (Baryon No. = 1)* 971
  - *Strong (Baryon No. ≥ 2)* 973
- Particle Invarance Principles and Symmetries 974
  - *General* 974
  - *Applications (Electromagnetic and Weak)* 976
  - *Applications (Strong)* 976
- Field Theories 978
  - *General* 978
  - *Quantum Field Theory* 978
  - *Gravitation and General Relativity* 979
- Scattering Theory 981
- Particle Accelerators 982

PHYSICS (NUCLEAR) 986
- Neutron Interactions with Matter 986
- Nuclear Properties and Reactions, $A \le 5$ 987
- Nuclear Properties and Reactions, $6 \le A \le 19$ 988
- Nuclear Properties and Reactions, $20 \le A \le 89$ 990
- Nuclear Properties and Reactions, $A \ge 90$ 994
- Nuclear Theory 1001

REACTOR TECHNOLOGY 1007
- Central Power Reactors 1007
- Marine and Portable Power Reactors 1013
- Process Heat and Desalination Reactors 1013
- Research and Test Reactors and Critical Assemblies 1013
- Reactor Theory, Components, Fuels, and Accessories 1015

GENERAL 1020

CORPORATE AUTHOR INDEX INDEX-1

PERSONAL AUTHOR INDEX INDEX-8

SUBJECT INDEX INDEX-65

REPORT NUMBER INDEX INDEX-159

JOURNAL LIST APPENDIX-1

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 8149, 8168, 8224, 9757, and 10122.

7985 (AERE-AM-105) A RAPID DETERMINATION OF ^{233}Pa (DI-ISOBUTYL CARBINOL AND METHYL ISOBUTYL KETONE EXTRACTION). Jenkins, W.; McMillan, J. W.; Rees, T. B. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1967. 5p. Dep. CFSTI. UK 1s, 9d.

Protactinium-233, together with protactinium-231 tracer, is initially separated by extraction into diisobutylcarbinol from 6M hydrochloric/4.5M sulphuric acid solution, followed by back extraction as the fluoride complex. Further purification is achieved by extraction into methyl isobutyl ketone from 6M hydrochloric acid solution, followed by back extraction as the fluoride complex. This latter extraction cycle is repeated until the necessary purification of the protactinium is attained. The protactinium-233 is determined by gamma spectrometry or beta counting, and the chemical yield is assessed by alpha counting the protactinium-231. The method is applicable to the determination of protactinium-233 in sulphuric, nitric, and hydrochloric acid solutions containing mixed fission products and stainless steel activation products. The coefficient of variation should not exceed 4% when counting statistics permit. (auth) (UK)

7986 (AERE-R-5617) THE DETERMINATION OF RUTHENIUM IN URANIUM CARBIDE-RUTHENIUM AND PLUTONIUM CARBIDE/URANIUM CARBIDE-RUTHENIUM CERMETS. Weldrick, G. J.; Wood, A. J.; Crossley, D.; Phillips, G.; Milner, G. W. C. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1967. 14p. Dep. CFSTI. UK 2s. 6d.

The cermet samples are dissolved by fusing with alkaline sodium peroxide under controlled conditions at 600°C in an alumina crucible. The cooled melt is extracted with water, and the resulting solution is acidified with hydrochloric acid. For determination of ruthenium, sodium hypochlorite is used to oxidize the ruthenium to the tetravalent state before extracting it with carbon tetrachloride to effect a separation from other sample constituents. Ruthenium is then recovered from the organic extracts with sodium hydroxide containing sodium bisulphite. This solution is acidified with hydrochloric acid and heated to 100°C to produce a stable chloro-complex of ruthenium, which is used for the spectrophotometric determination of this constituent at 485 mμ. Ru-103 tracer is employed to correct for any slight losses of ruthenium occurring in the separation procedure. For complete analysis of UC-Ru samples, controlled-potential coulometry is satisfactory for the determination of uranium after the removal of ruthenium by volatilization. The conventional method of combustion, followed by manometric measurement of the carbon dioxide, is suitable for the carbon determination. The precisions for the determination of the individual constituents are ±0.25% for uranium, ±0.5% for ruthenium and ±0.3% for carbon. (auth) (UK)

7987 (ANL-7264) MACRODETERMINATION OF OXYGEN IN URANIUM DIOXIDE COMPOSITES BY INERT-GAS FUSION. Goodspeed, Harvey T.; Pettis, Dewitt (Argonne National Lab., Ill.). Sept. 1967. Contract W-31-109-eng-38. 9p. Dep. CFSTI.

An inert-gas fusion method for the macrodetermination of oxygen in uranium dioxide composites is described. Sample sizes ranged around 300 mg. About 100 mg of CO_2 produced by the procedure was collected in absorption-weighing tubes and measured on a standard analytical balance. As an initial check on the method, it was applied with success to oxygen determinations for various standard materials other than UO_2 composites. When applied to uranium dioxide composites, the method gave results that again appear to be completely satisfactory when temperature is taken to be the critical factor and therefore controlled. Average recoveries of 99.9 and 100.1% of the theoretical oxygen content were obtained in the analysis of U_3O_8 and UO_2 standards, with standard deviations from the means of about 0.3%. The same degree of precision was obtained in the oxygen analysis of known samples of W−UO_2 composites. Results obtained in the oxygen analyses of composites of UO_2 and other metal oxides are presented in tabular form. (auth)

7988 (CEA-R-3269) DOSAGE DES RADIOELEMENTS PAR DENSITOMETRIE DE LEURS AUTORADIOGRAMMES. (Determination of Radioelements by Autoradiographie Densitometry). Auchapt, Jacqueline-Marguerite (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). June 1967. 37p. (In French). Dep.

The relation between the surface integral $\int D$ of the optical density curve of an autoradiogram and the activity of the radioelements that produced it was studied. It was checked experimentally that the curves $\int D = f$ (time), $\int D = f$ (activity), and $\int D = f$ (energy) are straight lines, with logarithmic coordinates; this makes calibration very easy. This calibration varies for different active supports because of autoabsorption. It is only possible to determine activities by this method in the case of radioelements that are either pure or present in mixtures of constant composition. The method is recommended in the case of electrophoresis or chromatography in two dimensions with spots of very low activity. It is possible to detect about 10^{-6} to 10^{-1} μCi/cm^2 for autoradiogram exposure times of from 2 hr to 24 days. (auth)

7989 (CONF-660905-2) ANALYSE PAR ACTIVATION AVEC NEUTRONS DE 14 MeV ET 3 MeV D'ELEMENTS DE NUMERO ATOMIQUE INFERIEUR A 30. (Activation Analysis with 14- and 3-MeV Neutrons of Elements of Atomic Number Below 30). Aude, G.; Laverlochere, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 1966. 31p. (In French).

Neutrons of 14- and 3-MeV are products of a 400-kV accelerator by the reactions (D + T) and (D + D), respectively. The installation used for the analytical research is described, including neutron generator, pneumatic tube, protective facilities, and control and measurement devices. Sensitivities and possible interferences were examined for various elements at the beginning of the Mendeleev table: B, O, F, Al, Si, P, Cr, Mn, Fe, Co, and Ni: Principally known for its application to the determination of oxygen, this technique also permits the nondestructive determination of other major elements. Examples related to cements and different types of steels are presented. (tr-auth)

7990 (IS-T-209) A MASS SPECTROMETRIC ANALYSIS OF THE OXYGEN ISOTOPES OF WATER VIA THE COBALT(III) FLUORIDE-WATER REACTION. Lantz, Larry Lee (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 55p. Dep. CFSTI.

Thesis.

A method for the conversion of oxygen in small water samples to molecular oxygen is described. The conversion takes place as a result of a reaction between water vapor and cobalt(III) fluoride held at 300°C. Operation of the necessary apparatus is simple and the time required to perform an analysis is short. Isotope abundance measurements are made directly on oxygen gas. Good measurements can be made from 10 to 20 μl of water. (auth)

7991 (MSAR-67-213) A CRITICAL REVIEW OF THE DEVELOPMENT OF TECHNIQUES FOR THE MEASUREMENT OF IMPURITIES IN SODIUM. Quarterly Progress Report, April–June 1967. Andrews, R. C.; Rodgers, S. J.; Tepper, R.; Udavcak, R. J. (MSA Research Corp., Evans City, Pa.). Dec. 1967. Contract AT(11-1)-765. 46p. Dep. CFSTI.

The feasibility of laboratory and instream methods for determination of contaminants in sodium was investigated. Low-contaminant-level standards were available. High-temperature mass spectroscopy of off gases during high-temperature refluxing of sodium was found to duplicate work at other facilities and terminated before performance of critical experiments. Measurements of variations in magnetic moments due to impurities lacked specificity and sensitivity. Surface tension changes of sodium in relation to the contaminants appear to offer promise as an analytical tool. Sensitivity has yet to be established. Studies of impurity extraction in organic solvents were terminated because of lack of accuracy, difficulty in maintaining reagent purity, and interfering side reactions. Physical property changes as carbon detectors were immeasurable at low contaminant levels. Experiments to demonstrate concentration of oxygen by an electric potential were unsuccessful. The Coulter counter principle (electric sensing of particles) lacked validity. Erratic results were obtained in the continuous hydrogen monitoring of the cover gas. (M.C.G.)

7992 (NBS-TN-428) ACTIVATION ANALYSIS: COCKCROFT–WALTON GENERATOR, NUCLEAR REACTOR, LINAC, JULY 1966–JUNE 1967. DeVoe, James R. (ed.) (National Bureau of Standards, Washington, D. C.). Nov. 1967. 90p. GPO $0.55.

The irradiation facilities of the nuclear reactor, Linac, and Cockcroft–Walton generator are described. The initial installation of pneumatic transfer tubes was completed. A clean room was completed for pre-irradiation chemical separation for high-sensitivity activation analysis. A dual-sample biaxial rotating 14-MeV neutron-irradiation assembly was tested. This assembly is part of a system that is controlled by a relay type of programmer to automate those irradiation steps that adversely affect precision of the analysis. This system was used to improve the precision of analysis for oxygen and fluorine. As a result of improved precision with the 14-MeV neutron irradiation, a study of systematic errors is now possible. Efforts to establish a reproducible correction factor for neutron and gamma absorption between different matrices within the sample showed considerable promise. Standard Reference Material (SRM) steel chip Nos. 3b, 3c, and 30f were analyzed for vanadium. Preliminary analyses of high-purity platinum (a potential SRM) showed silver, copper, gold, palladium, and iridium at the ppM level. Future biological SRM's, (tree leaves, and beef liver) were tested for homogeneity and found satisfactory. A variety of service analyses were performed. In particular, very pure aluminum was found to contain fractions of a ppM of chromium and scandium. Additional efforts are being made to monitor reactor neutron fluxes. Additional nuclear instrumentation is being assembled to improve the versatility of the analysis technique. Performance of the bremsstrahlung target, used with the linear electron accelerator, was evaluated. Photon intensity distribution and stability was found to be within usable range. Analyses using the (γ,n) or (γ,p) reactions were developed for ma[illegible]um in steels, and carbon in sodium metal. (auth)

7993 (RCC-M-210) CERIUM (IV)–ARSENITE REACTION IN MICRODETERMINATION OF IODINE FOR SPECIFIC ACTIVITY MEASUREMENT. Appleby, A.; Spillett, R. E. (Radiochemical Centre, Amersham (England)). Oct. 1967. 7p. Dep. CFSTI. UK 1s. 9d.

The procedure described is based on the reaction $2\ Ce^{4+} + HasO_2 + H_2O \rightarrow 2Ce^{3+} + HasO_3 + 2H^+$, which is catalyzed by iodide ion. For small intervals of time this reaction may be regarded as first order with regard to cerium and catalyst. The reaction is followed by observation of the variation of percentage transmission with time, using a simple Evans Electroselenium photoelectric colorimeter. It is possible, by this method, to determine iodide ion in the concentration range 5×10^{-3} to 1 μg/ml, and the method affords a rapid, sensitive, accurate, and simple means of estimating specific activities of ^{125}I and ^{131}I samples using quantities of activity of the order of a millicurie. The presence of Cl^- or Br^- does not interfere. (UK)

7994 (ANL-Trans-543) THE ANALYTICAL APPLICATIONS OF THE (α,n) REACTION. Adloff, J.; Schleiffer, J.; Urlacher, C. Translated for Argonne National Lab., Ill., from Bull. Soc. Chim. Fr., No. 2, 698-703(1966). 21p. Dep. CFSTI. JCL $2.60 fs, $0.89 mf.

It is shown that the neutron emission arising from (α,n) nuclear reactions can be used to determine several elements, particularly ^{18}O. The detection system consists of 2 concentric rings with diameters of 10 and 17 cm, respectively, each supplied with 6 identical neutron counters arranged in a regular fashion around the rings. The whole system is enclosed in a block of paraffin 40 cm on a side. The detectors are BF_3 counters. The central paraffin block is enclosed in a cadmium foil and a thick wall of paraffin. The efficiency of the system was found to be 13%. It was found that under α bombardment, about 20 elements give rise to neutron emission that is proportional to the intensity of the α source and dependent on the amount of target element and its nuclear properties. (M.C.G.)

7995 TITRIMETRIC METHOD OF DETERMINATION OF MICROQUANTITIES OF URANIUM. Lin, Ch'ang-shan; P'ang, Shu-wei. Yuan Tzu Neng, No. 6, 558-61(1965). (In Chinese).

The method is based on reduction of U^{6+} to U^{4+} in a Pb reducer and subsequent titration of U^{4+} with $Ce(SO_4)_2$ in the presence of o-phenanthroline as initiator. The reduction of U^{6+} proceeds quantitatively in a medium of 2 to 5N HCl. U^{4+}, when formed, is not oxidized by O_2 of the air for 3 hr. During titration, concentration of HCl in the solution should be 2 to 3N. As a catalyst, 0.02 to 0.2 ml of H_3PO_4 is added. This method permits determination of 5 to 500 γU with an error from –0.6 to +1%. (JPRS)

7996 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN PHOSPHATE EXTRACTS. Chu, Tsu-heng; Yeh, Hsu-shen. Yuan Tzu Neng, No. 12, 1022-8(1965). (In Chinese).

A study was made of the conditions for spectrophotometric determination of microquantities of U in solutions resulting from the processing of phosphorites with sulfuric acid. The interfering elements (V, La, and Ce) are separated by extraction with chloroform in the form of cupferronates, followed by photometry of the complex of U^{4+} with Arsenazo III (I) in a medium of 6N HCl. To 5 ml of the solution (30 to 40 γ of U) 1N $KMnO_4$ is added dropwise until appearance of a stable pink color, then the complex is extracted three times using, each time, 3 ml of 3.3% solution of cupferron in $CHCl_3$. To the aqueous phase, containing U^{6+} dilute HCl is added and 10 to 15 granules of metallic Zn are introduced along with 10 mg of ascorbic acid. After 30 min, the solution is diluted to 50 ml; 1 ml of the solution is transferred into a 25 ml measuring flask containing 6N HCl; 2 ml of 0.05% solution of (I) are added; the solution with 6N HCl; and, after 5 min, photometry is performed at 665 mμ. Beer's law is observed within the limits of 0 to 2 γ/ml concentrations of U up to 1000-fold quantities of HPO_4^{2-} do not interfere. In the determination of 0.4 g/liter of U the error is 1.2%. The analysis takes 1.5 hr. (JPRS)

7997 EXTRACTIVE PHOTOMETRIC DETERMINATION OF MICROQUANTITIES OF HEXAVALENT URANIUM WITH USE OF ARSENAZO III. Chu, Pen-jen; Yang, Kuo-ying; Shen, Kuang-hua; Ch'eng, Yuan-ti. Yuan Tzu Neng, No. 9, 792-8(1965). (In Chinese).

In determining U^{6+} use was made of extractive-photometric method, which includes the extraction of U with a solution of tributyl phosphate in CCl_4 from an aqueous solution with a pH of 2 to 2.5, re-extraction of U with Arsenazo III solution, and photometry of the re-extract. (JPRS)

7998 A REASSESSMENT OF RHODIZONIC ACID AS A QUALITATIVE REAGENT. Chalmers, Robert A.; Telling, Geoffrey M. (Univ. of Aberdeen, Scotland). Mikrochim. Acta, No. 6, 1126-35(1967).

Rhodizonic acid was re-examined as a qualitative reagent, and it is shown that it will react with many metals to give characteristic spectra if the dielectric constant of the solvent is sufficiently low and if a protective colloid is added. The range of application of rhodizonic acid was considerably extended in this way. (auth)

7999 A NEW VOLUMETRIC METHOD FOR MICRODETERMINATION OF TELLURIUM OR MERCURY. Saxena, O. C. (Univ. of Allahabad, India). Mikrochim. Acta, No. 6, 1123-5(1967).

A volumetric method for the determination of tellurium(IV) or mercury(II) in the mg range is proposed by using the redox process. Reduction is effected by boiling with an excess of reducing sugar in alkali solution. The metals obtained are reoxidized by means of ferric chloride solutions. The ferrous ions formed are titrated against a standard solution of ceric sulfate using N-phenylanthranilic acid as indicator. The interference due to various cations was investigated. (auth)

8000 STUDIES IN QUALITATIVE INORGANIC ANALYSIS. PART XXIX. QUALITATIVE ANALYSIS OF THE CALCIUM GROUP. Jones, W. F. (Worcester Technical Coll., Deansway, Eng.). Mikrochim. Acta, No. 6, 1004-18(1967).

The various methods by which the elements barium, strontium, and calcium are precipitated and separated as a group in qualitative analysis are discussed, and confirmatory tests are summarized. (auth)

8001 SEPARATION OF RADIOELEMENTS BY THIN-LAYER CHROMATOGRAPHY. **Gandia, V.; Sanchez Batanero, P. An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 333-8(Nov.-Dec. 1967). (In Spanish).**

The separation of the following radioactive ions, ^{90}Sr, ^{137}Cs, ^{45}Ca, ^{95}Zr, ^{140}La, ^{144}Ce, and ^{65}Zn, was studied using thin-layer chromatography. Silica gel G or silica gel MN-N was used as adsorbent, and a mixture of methanol, hydrochloric acid, and water in various proportions was used as eluent. Some important variations of the values of R_x (relative migration rate) were observed when the concentration of HCl in the eluent system was modified. A quantitative method was tried for the determination of small amounts of ^{90}Sr, ^{137}Cs, and ^{45}Ca separated by this method. (tr-auth)

8002 RECOIL TECHNIQUE AND ITS POSSIBLE USE IN ACTIVATION ANALYSIS. **Hahn, Richard L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Anal. Chem., 40: 219-21(Jan. 1968). (ORNL-P-3013).**

Some of the principles of recoil phenomena are discussed including a few illustrative experiments using copper-oxygen samples. The experiments indicated that by taking advantage of differences in recoil properties of different nuclides, satisfactory separations of radioactive products may be achieved. This conclusion has potential use in activation analysis, especially for the determination of surface impurities, like oxygen or carbon, on medium weight elements. The technique is similar to that of the usual activation analysis, and is simple, not requiring the more sophisticated apparatus needed for the counting of particles emitted during irradiation. (D.H.M.)

8003 SIMULTANEOUS DETERMINATION OF ^{55}Fe AND STABLE IRON BY LIQUID SCINTILLATION COUNTING. **Cosolito, Frank J.; Cohen, Norman; Petrow, Henry G. (New York Univ. Medical Center, New York). Anal. Chem., 40: 213-15(Jan. 1968).**

A rapid and simple procedure is described for the simultaneous determination of ^{55}Fe and stable iron by solvent extraction using bis(2-ethylhexyl) phosphate (EHPA) and liquid scintillation counting. Samples containing up to 50 mg of stable iron may be analyzed for ^{55}Fe; however, the maximum sensitivity is achieved if the sample size is chosen so as to provide 20 to 30 mg of stable iron. To illustrate the applicability of the method for determining ^{55}Fe in biological materials, a blood sample was analyzed in duplicate by both this method and by electrodeposition. The values obtained by solvent extraction and liquid scintillation for stable iron were 5.6 and 5.3 mg and for ^{55}Fe were 10.75 and 10.55 pCi. The values obtained by electrodeposition and windowless proportional counting for stable iron were 4.75 and 4.95 mg and for ^{55}Fe were 9.97 and 11.89 pCi. The procedure is currently being expanded to include the additional determination of ^{59}Fe along with ^{55}Fe and stable iron. (D.H.M.)

8004 SPECTROPHOTOMETRIC DETERMINATION OF YTTRIUM OR LANTHANUM IN ALUMINUM ALLOYS USING THE SEPARATION OF ALUMINUM BY OXINE EXTRACTION. **Kaneko, Keiji; Tatsuno, Tsuguo; Kaneko, Hiroko; Goseki, Shoichi (Agency of Industrial Science and Tech., Tokyo). Bunseki Kagaku, 12: 1304-8(1967). (In Japanese).**

A method for the spectrophotometric determination of yttrium or lanthanum in aluminum alloys using the separation of aluminum by oxin extraction has been established. More than 0.1 g of aluminum alloy is dissolved in 3 N hydrochloric acid. To remove the majority of aluminum and interfering metals such as nickel etc., the solution is treated with acetic acid and oxin, the pH of the solution is adjusted to 4.5 with 20% hexamethylenetetramine and 1 N ammonia water, and the metal oxinates are extracted by shaking with 5% solution of oxin in chloroform. The pH of the aqueous solution is adjusted to 6.4 (or 6.6 for lanthanum), and it is treated with 1.8 ml of 10% solution of acetylacetone in ethyl alcohol and 2.5 ml of 0.05% MethylThymol Blue solution. The absorbance of the solution is measured at 610 mμ against reference blank. Relative errors in the determinations of yttrium and lanthanum over the range from 0.05 to 7.0% are both within ±3%. (auth)

8005 STUDY OF THE POSSIBILITIES OF DETERMINING OXYGEN IN ZIRCONIUM, MOLYBDENUM, HAFNIUM, AND TUNGSTEN BY IRRADIATION WITH ^{3}He AND ^{4}He PARTICLES. **Revel, G.; Albert, Ph. (CNRS, Vitry-sur-Seine, France). J. Nucl. Mater., 25: 87-92(1968). (In French).**

By means of irradiation with ^{3}He nuclei of energy below 11 MeV, oxygen can be determined without the need of chemical separation in zirconium, molybdenum, hafnium, and tungsten. The sensitivity limits achieved (10^{-8} in the case of zirconium) are at present adequate for the study of these metals. With the experimental conditions chosen, no other impurity can interfere with the oxygen analyses, which agree well with analyses performed by other techniques. Carbon could be determined by a method similar to that used for oxygen. However, the influence of certain light elements that might be present in trace quantities would need to be examined in this connection. Apparent analyses already made permit an upper limit to be fixed for the carbon concentration. For the purest sample this is a few ppM. The possibility of oxygen determination in zirconium by α irradiation was studied, and the precision and limitations of this method are discussed. (auth)

8006 GAMMA-ACTIVATION METHOD FOR THE DETERMINING OF Br, Ag, AND In IN SOME MATERIALS. **Abrams, I. A.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 45-9(1967). (In Russian).**

A method for the determining of Br, Ag and In in some materials by using the (γ,γ') reaction is described. The method gives a high degree of precision and selectivity if the amount of the elements in the materials is a few percent. (auth)

8007 NEUTRON-ACTIVATION ANALYSIS OF MANGANESE IN POLYSULPHIDE MATERIALS. **Conrad, F. J.; Kenna, B. T. (Sandia Lab., Albuquerque, N. Mex.). Talanta, 14: 1339-40(Nov. 1967).**

A fast nondestructive neutron activation analysis method was developed for manganese in polysulphide adhesives. Samples are irradiated for 20 min at a thermal flux of 2×10^{10} n cm^{-2} sec^{-1}. The net activity in the 0.845-MeV gamma peak of ^{56}Mn produced by the (n,γ) reaction in the sample is compared with the activity obtained from a weighed amount of pure manganese irradiated at the same time. Samples containing 2 to 3% of manganese were analyzed with a relative standard deviation of 2.9%. (auth) (UK)

8008 POTENTIOMETRIC TITRATION WITH CHELATING AGENTS USING METAL OXIDE ELECTRODE AS AN INDICATOR ELECTRODE. **Nomura, Tsuyoshi; Nakagawa, Genkichi (Nagoya Inst. of Tech., Japan). Bunseki Kagaku, 12: 1314-19(1967). (In Japanese).**

A spiral platinum wire electrode coated with manganese dioxide can be used as an indicator electrode for the potentiometric titration of various metal cations with EDTA or EGTA. When a small amount of manganese ion is added before the titration, the potential of the indicator electrode at 25°C is given by the following expression: $E = E^{0} - 0.0296 \log [Mn^{2+}] - 0.1183$ pH where the concentration is assumed to be equal to the activity. It was found that the electrode potential is dependent on the manganese ion concentration in the solution and its pH value. The titration must be carried out in neutral or alkaline solutions, because stability constant of managanese-EDTA complex is not so great, and the indicator electrode attains equilibrium more rapidly in alkaline solutions than in neutral. Chloride ion does not interfere with the MnO_2 electrode, permitting the use of an Ag-AgCl reference electrode, and the equivalence point is determined from the maximum slope of the titration curve. In the case of titrations with EDTA, Cu, Cd, Pb, Zn, and Co can be determined at pH about 7 in a succinate medium, and Cu, Cd, Zn, Co, Ca, and Sr at pH about 9 in ammoniacal medium. In the case with EGTA, Ca can be selectively determined in ammoniacal medium (pH about 9) in the presence of five fold excess of Mg, which forms only a less stable complex with EGTA. (auth)

8009 REMOTELY OPERATING POLAROGRAPHIC DETERMINATION OF URANIUM IN PROCESS WASTE SOLUTIONS. **Emura, Satoru; Sugikawa, Susumu (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 12: 1345-50(1967). (In Japanese).**

A remotely operating polarograph was developed and a new polarographic method was established for the determination of uranium in Purex process waste. The interference of dissolved organic solvent (TBP) was eliminated by adding ammonium sulfate (3.5 M) as a coagulator. Also, interfering nitrous acid was destroyed by urea. In a polarographic cell, 500 μl of the sample solution and 5.0 ml of supporting electrolyte containing 3.5 M ammonium sulfate, 1 M nitric acid, and 0.1 M urea are mixed. After deaeration with nitrogen for 15 minutes, dc polarogram is recorded from −0.3 to −0.9 V vs mercury anode. Uranium content is determined referring to a calibration curve. For the synthetic waste solution containing $9.0 \times 10^{-4} \sim 5 \times 10^{-2}$ M uranium, the relative standard deviation was less than 2.5 percent. Precision data for bench top as well as for the remote procedure showed no significant difference. (auth)

8010 DETERMINATION OF OXYGEN IN FERROSILICON BY 14 MeV NEUTRON ACTIVATION. **Ishii, Daido; Mori, Hideo;**

Hirose, Yoji (Nagoya Univ., Japan). Bunseki Kagaku, 12: 1370-3(1967). (In Japanese).

Neutron activation (14 MeV) with gold as an internal standard has been employed in the determination of a trace amount of oxygen in ferrosilicon. In order to remove the disturbance towards the count of ^{16}N and ^{197m}Au with ^{28}Al, produced from ferrosilicon, experimental conditions and discriminator level of ^{16}N were examined. To ferrosilicon powder, silicic anhydride is added stepwise and calibration curve was prepared by plotting the added oxygen amounts and S_N/S_{Au}. From the slope of the calibration the amount of oxygen in each sample is calculated. The experiments were carried out ranging for two days with the same sample. While a great change was made on the neutron bundle when the gold internal standard method, was not employed, any influences have not been made with this method. The experimental facts indicated that the gold internal standard method was found to be effective as a practical analytical method. (auth)

8011 DETERMINATION OF WATER–HEAVY WATER MIXTURES BY ^{19}F NUCLEAR MAGNETIC RESONANCE. **Deverell, Christopher; Schaumburg, Kjeld** (National Research Council, Ottawa). Anal. Chem., 39: 1879-80(Dec. 1967).

The method for determining the isotopic composition of water–heavy water mixtures is based on the observation that the fluorine chemical shift in alkali fluoride solutions is sensitive to the isotopic composition of the solvent. The ^{19}F NMR signal varied in width from approximately 25 Hz in H_2O to 9 Hz in D_2O. (M.C.G.)

8012 A METHOD FOR SIMULTANEOUS DETERMINATION OF ^{90}Sr–^{45}Ca. **Krawielitzki, K.; Nehring, K.** (Oskar-Kellner-Institut fuer Tierernaehrung, Rostock, Ger). Isotopenpraxis, 3: 421-2(1967). (In German).

A method is given for the simultaneous determination of ^{90}Sr and ^{45}Ca. The calcium is precipitated by classical methods as the oxalate and the Sr is carried down completely with it. The activity of the precipitate is measured with an end-window counter first without and then with a foil of Al. From the height of the counting rates with and without the absorption foil, the partial counting rates for ^{45}Ca and ^{90}Sr can be determined exactly. (J.S.R.)

8013 DETERMINATION OF RARE EARTH ELEMENTS IN HOT SPRING WATER. No. 2. BY RADIOACTIVATION METHOD. **Oda, Toshiyuki** (Kyushu Univ., Japan). Onken Kiyo, 19: 166-74(June 1967). (In Japanese).

A radioactivation method for determination of rare earth elements in hot spring waters was studied and the concentrations of those elements in some waters such as 5 Beppu hot springs, Wairakei (New Zealand), and seawater were determined. The rare earth elements that were coprecipitated with cadmium oxalate from 10 liters of spring waters and ignited were irradiated. After irradiation, the rare earth elements were separated radiochemically, and the radioactivities were measured with the 512-channel pulse-height analyzer. The concentrations of Sc, La, Sm, Eu, and Dy in the waters were 5.340 to 0.054, 0.81 to 0.02, 0.342 to 0.010, 0.043 to 0.001, 0.46 to 0.02 μg/l, respectively. The concentration of La in Beppu hot spring waters was considerably less than those in Nasu, Kusatsu, and Wairakei's. (NSA of Japan)

8014 GAMMA RESONANCE SPECTROSCOPY (MOESSBAUER SPECTROSCOPY) IN CHEMISTRY. **Goldanskii, V. I.** (Inst. of Chemical Physics, Moscow). Angew. Chem., 79: 844-58(1967). (In German).

The principles of the Moessbauer effect and the characteristics of the Moessbauer (γ resonance) spectra are briefly described. Typical examples of the application of this spectroscopic method, especially in chemistry and biology, are reported. Experimental results using Moessbauer spectroscopy obtained principally in the Soviet Union are reported. (tr-auth)

8015 AMPEROMETRIC DETERMINATION OF SULFUR IN PLUTONIUM SULFIDE AND PLUTONIUM–URANIUM SULFIDE CERAMIC FUELS. **Evans, Harold B.; Mori, Shiro** (Argonne National Lab., Ill.). Anal. Chem., 40: 217-18(Jan. 1968).

A method for the determination of sulfur in plutonium sulfide and uranium sulfide–plutonium sulfide mixture was developed for a program that evaluates the ceramic fuels used in nuclear reactors. In the presence of alpha activity, a glove box procedure was adopted that consisted of sample dissolution in a nitric acid–bromine mixture and the subsequent separation of the actinides with Dowex 50 X8 cation resin. The eluate containing the sulfate was amperometrically titrated with lead nitrate solution. With Dowex 50W X8 approximately 0.26% of the U and 0.36% of the Pu broke through the column. The recovery with this cation resin was approximately 99.7%. The optimum pH was found at 5.0 where the sulfur recovery averaged 99.9% with a relative standard deviation of ±0.25%. Tests showed that the type and amount of supporting of electrolyte greatly influenced the final results. (D.H.M.)

8016 SPECTROPHOTOMETRIC DETERMINATION OF THORIUM WITH MOLYBDOPHOSPHORIC ACID. **Madison, Bryan L.; Guyon, John C.** (Univ. of Missouri, Columbia). Anal. Chem., 39: 1706-8(Dec. 1967).

A sensitive, spectrophotometric technique for determination of thorium was developed. The method is based on the reduction product of a presumed thorium molybdophosphoric acid heteropoly complex. The effects of variables on the color-forming reactions are described, along with optimum conditions for the formation of the blue hue. The method is sensitive for thorium in the range from 0.2 to 1000 μg and by proper choice of size of sample and cells the limits can be varied widely. The molar absorptivity was calculated to be 3.3×10^4. The method is subject to several interferences; however, the thorium can be cleanly separated using a solvent extraction procedure. The system was applied to the determination of thorium in a monazite sand. (auth)

8017 HIGHLY SENSITIVE SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF RARE EARTHS AND NICKEL. **de Wet, W. J.; Behrens, G. B.** (National Nuclear Research Inst., Pelindaba, South Africa). Anal. Chem., 40: 200-2(Jan. 1968).

A spectrophotometric method of determining minute quantities of the rare earths (except yttrium) and nickel that is based on complex formation with a metallochromic indicator of the complexan-type, in particular Xylenol Orange (XO), and a long-chain quaternary salt like cetylpyridinium bromide (CPB) is reported. The stability constants for the RE-XO-CPB complexes and Ni-XO-CPB complex were determined from the curves of the method of continuous variations. The logarithm of this constant obtained for Ce was 14.8 and the published value for La is 13.6. The remaining rare earths gave values in between these two figures. A value of 12.2 was derived for the Ni complex at 20°C. For the first nine rare earths (La to Dy) quantities as small as 0.15 μg in a sample and for the remainder of the rare earths about 0.2 μg can be determined with a reasonable degree of precision. The useful practical range falls between 0.1 and 0.5 ppM (or more) concentration levels in working solutions (for 1-cm cells on a double beam instrument). (D.H.M.)

8018 COULOMETRIC TITRATION OF POLONIUM AT THE MICROGRAM LEVEL. **Propst, R. C.** (E. I. du Pont de Nemours and Co., Aiken, S. C.). Anal. Chem., 40: 244-6(Jan. 1968). (DP-MS-67-50).

In an attempt to develop a direct coulometric method for the determination of polonium, the electrodeposition of ^{210}Po was studied. Perchloric acid was chosen for the electrolyte because it is more resistant to radiolytic degradation than nitric and hydrochloric acids. The electrodeposition behavior and radiolysis effects are discussed. Relatively poor precision (5%) was obtained in the determination of ^{210}Po in $0.1\underline{M}$ perchloric acid because of interference from radiolysis products. Possible sources of error were investigated. (D.H.M.)

8019 STUDY OF CERIUM(IV)–THALLIUM(I) REACTION AND ANALYSIS OF THALLIUM(I) MIXTURES BY KINETIC DIFFERENCES. **Schenk, George H.; Bazzelle, William E.** (Wayne State Univ., Detroit). Anal. Chem., 40: 162-8(Jan. 1968).

The uncatalyzed cerium(IV)–thallium(I) reaction in $0.125\underline{M}$ sulfuric acid exhibits an extremely slow but measurable rate in the dark, while in room light, the rate of disappearance of cerium(IV) increases, presumably because of thallium(I)-catalyzed photoreduction. Catalysis by manganese(III) was so effective that photometric titration of thallium(I) with cerium(IV) titrant was possible. Two types of thallium(I)–metal ion mixtures can be analyzed on the basis of kinetic differences alone. In the first type, metal ions such as iron(II) react rapidly with the cerium(IV) titrant in the absence of catalyst before thallium(I) reacts significantly. Then the catalyst is added and the thallium(I) is titrated with cerium(IV). In the second type of mixture, the catalyst is added at the start, and thallium(I) reacts rapidly with the cerium(IV) titrant before the other metal ions or reducing agents react significantly. The reducing agents studied were mercury(I), arsenic(III), and chromium(III). Theoretical calculations indicated the reactions of these substances with cerium(IV) should be negligible, but weak catalysis by manganese(III) apparently causes significant reaction above equivalent concentrations. (auth)

8020 AUTOMATIC GROUP SEPARATION SYSTEM FOR THE SIMULTANEOUS DETERMINATION OF A GREAT NUMBER OF ELEMENTS IN BIOLOGICAL MATERIAL. RECOVERY AND REPRODUCIBILITY STUDIES. **Samsahl, Knut; Wester, Per Olov; Landstrom, Ove** (Aktiebolaget Atomenergi, Stockholm). Anal. Chem., 40: 181-7(Jan. 1968).

An automatic group separation system for the determination of about 40 elements was tested on biological material. The method is based on ion exchange separation and extraction chromatography combined with gamma spectrometry. Sixteen groups of elements suitable for gamma spectrometry are obtained. The reproducibility and recovery of added activities to biological samples of the following 32 elements were studied: Ag, As, Ba, Br, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Hf, Hg, In, K, La, Mn, Mo, Na, P, Rb, Sb, Sc, Se, Sm, Sr, Th, U, W, and Zn. Recovery values $\geqslant 90\%$ were obtained for all elements except In, Se, Th, and U. A standard error of the mean value $\leqslant 3\%$ was obtained for all elements except Ba and Th. The reproducibility of the method was also tested by repeated analysis of a biological standard. The precision was better than 10% for all elements except Sb and Th, and for most of the elements better than 5%. (auth)

8021 DETERMINATION OF OXYGEN–ZIRCONIUM RATIO IN OXYGEN-DEFICIENT ZIRCONIA. **Heffelfinger, R. E.; Litsey, C. T.; Chase, D. L.; Henry, W. M. (Battelle Memorial Inst., Columbus, Ohio). Anal. Chem., 40: 171-4(Jan. 1968).**

Two techniques are described for the determination of the O–Zr ratio in oxygen-deficient zirconia. The reaction between oxygen-deficient zirconia and chlorine at 800°C is discussed as well as the reaction in vacuum at 650°C between U_3O_8 and oxygen-deficient zirconia. The results from the techniques are checked against thermal-balance data. Precision tests with the U_3O_8 method gave oxygen-to-zirconia ratios ranging from 1.9852 to 1.9871 for eight determinations. The average was 1.9861; relative standard deviation was 0.03%. (auth)

8022 RAPID CALCULATION OF SENSITIVITIES, INTERFERENCES, AND OPTIMUM BOMBARDING ENERGIES IN ^{3}He ACTIVATION ANALYSIS. **Ricci, Enzo; Hahn, R. L. (Oak Ridge National Lab., Tenn.). Anal. Chem., 40: 54-60(Jan. 1968). (ORNL-P-3405).**

To facilitate calculations of sensitivities and interferences in terms of bombarding energies, E, in ^{3}He activation analysis, an approximate method was developed for the rapid computation of the average cross section, $\bar{\sigma}$. This energy-dependent parameter is otherwise difficult to obtain by rigorous mathematics and, yet, it is vital in those calculations because: the analytical sensitivity is directly proportional to $\bar{\sigma}$; and the interference is shown here to depend on the ratio, $\bar{\sigma}_i/\bar{\sigma}_s$, for the interfering and the sought reactions, respectively. The method is based on the straight-line fitting of excitation functions, which leads to the final simple formula $\bar{\sigma} = 2/3\ mE - a + b/E^2$. The constants m, a, b, and other important parameters are given for the 12 most significant nuclear reactions of ^{3}He ions with the elements that display the highest sensitivities in ^{3}He activation: Be, B, C, N, O, and F. Detailed typical examples are given to illustrate the wide usefulness of the proposed method, even under quite unfavorable analytical conditions; a number of calculations of average cross sections, sensitivities, and ratios, $\bar{\sigma}_i/\bar{\sigma}_s$, are included. The variation of the latter with E is used to find optimum experimental ^{3}He bombarding energies for particular analyses. The average error of the method is found to be no larger, and in most cases much less, than 13.5%. (auth)

8023 COMPLETE ANALYSIS OF URANIUM–NIOBIUM–ZIRCONIUM ALLOY BY X-RAY ABSORPTION EDGE TECHNIQUE. **Stewart, J. H. Jr.; Barton, T. H. Jr.; Ferguson, M. R. (Union Carbide Corp., Oak Ridge, Tenn.). Anal. Chem., 40: 27-9(Jan. 1968).**

The x-ray absorption edge technique was extended to include the complete analysis of a U–Nb–Zr alloy. The alloy was dissolved in 6N HCl, HNO_3 and HF were added, and the U determined. A rapid tri-n-butyl phosphate (TBP) extraction removed the bulk uranium. Nb and Zr were then both determined in the aqueous phase. The intensity of the transmitted primary x-ray beam taken at wavelengths on each side of the three absorption edges was used to determine the concentrations of the three components. Twelve samples may be analyzed for the three components in an 8-hr period. The relative standard deviation of this method for the analysis of metal chips is 0.34% for U, 0.90% for Nb, and 2.2% for Zr. (auth)

8024 RAPID DETERMINATION OF RHODIUM AND PALLADIUM USING LIQUID–LIQUID EXTRACTION WITH TRICAPRYL MONOMETHYL AMMONIUM CHLORIDE AND FLAME PHOTOMETRY. **Campbell, Milton H. (Atlantic Richfield Hanford Co., Richland, Wash.). Anal. Chem., 40: 6-9 (Jan. 1968).**

Rhodium and palladium were quantitatively separated from waste solutions of a uranium and plutonium recovery by liquid–liquid extraction with tricapryl monomethyl ammonium chloride. The pH effect on the extraction was investigated and pH 8 was found to be optimum. The effects of several anionic forms of the extractant, extractant concentration, contact time, and temperature are reported. Potential strippants for the organic phase were found and the diverse ion effect was evaluated. Decontamination factors were measured; that for ^{137}Cs was excellent, ^{106}Ru was only 10, and for the pertechnetate ion was 0.3. Analysis by flame photometry was satisfactory in the range of 1 to 100 μg/ml in the sample with standard deviation of ±1.0 μg/ml of sample. The detection level can be lowered to 0.05 μg/ml by concentrating the organic extract with a common strippant. (auth)

8025 QUANTITATIVE DETERMINATION OF RARE EARTHS IN YTTRIUM OXIDE BY SPECTROPHOTOLUMINESCENCE. **Ozawa, Lyuji; Toryu, Takao (Dai Nippon Toryo Co., Ltd., Kanagawa, Japan). Anal. Chem., 40: 187-90(Jan. 1968).**

A technique for the quantitative determination of small amounts of rare earth impurities in Y_2O_3 (powder form) is described. Rare earths (RE) detected by spectrophotoluminescence in the visible and near ultraviolet spectral region were Pr, Sm, Eu, Gd, Tb, Dy, Ho, Er, and Tm; other rare earths in Y_2O_3 had no luminescence. The emission and excitation spectra of rare earth ions in Y_2O_3 indicated a sharp difference in the spectra with regard to the energy distribution. The emission intensities increased linearly with rare earth concentration up to about 1×10^{-3} mole $(RE)_2O_3$ per mole Y_2O_3, except for Gd (up to about 2×10^{-2} mole). The lower limit for emission detection was in the region between 10^{-8} and 10^{-6} mole, depending on the rare earth element; the lower limit for Gd and Sm was 10^{-5} mole because of poor emission. No correction of the calibration curves had to be made when the coexistence of total impurities of other rare earths in Y_2O_3 was below 10^{-5} mole. The data indicated that spectrophotoluminescence is a suitable technique for the quantitative analysis of rare earth impurities in highly pure Y_2O_3. (auth)

8026 DETERMINATION OF IRON AND NICKEL IN URANIUM BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. **Shepherd, G. A.; Johnson, A. J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. At. Absorption Newslett., 6: 114-16(Sept.-Oct. 1967).**

Iron and nickel were determined in uranium by three atomic absorption techniques with an accuracy comparable to that obtained with colorimetry. The use of the ion exchange procedure described makes possible the determination of iron at less than 50 μg/g in the uranium. It also permits the safe analysis of enriched uranium samples without special equipment. Of the three techniques, the method of additions is the least accurate. (auth)

8027 RADIOCHEMICAL PROCEDURE FOR SEPARATING SULFUR. **Lagarde, Monique; Simonoof, Gabriel (Facultes des Sciences, Bordeaux). Bull. Soc. Chim. Fr., No. 10, 3668-9(Oct. 1967). (In French).**

A procedure for separating sulfur in the presence of various radioactive compounds is suggested. This method must be consistent with a determination of ^{35}S by its β^- radioactivity at very low energy (167 keV). After adding an entraining agent in the form of H_2SO_4, sulfur was precipitated as benzidine sulfate. The interfering elements were eliminated by precipitating with soda and purifying with isopropyl ether. The sulfate, which is soluble in an alkaline medium, was then precipitated again with benzidine chloride. The yield, determined by weight, varied from 40 to 70% according to the process of dissolution of the irradiated targets. The purity of the sources obtained enabled the isotope, ^{35}S, to be studied with no interference from other radionucleides. (auth)

8028 DETERMINATION OF SILICON IN MINERAL OIL BY FAST NEUTRON ACTIVATION. **Daniel, R.; Haerdi, W.; Monnier, D. (Univ., Geneva). Chimia (Aarau), 21: 544-6(Nov. 15, 1967). (In French).**

A nondestructive activation analysis method for quantitative determination of silicon in fuels was studied according to the reaction ^{28}Si(n,p)^{28}Al. If vanadium is present the best method consists of irradiating with 14-MeV neutrons. In absence of vanadium reactor irradiation is quite convenient. (auth)

8029 USE OF THE MAXIMUM-LIKELIHOOD METHOD FOR THE EVALUATION OF MAXIMUM SENSITIVITY FOR ACTIVATION ANALYSIS IN THE PRESENCE OF INTERFERING ACTIVITIES. **Quittner, P. (Central Research Inst. for Physics, Budapest). Acta Chim. Acad. Sci. Hung., 54: 127-31(1967).**

A general expression was obtained by the maximum-likelihood method for the maximum sensitivity of activation analysis in the presence of interfering activities produced by in-pile irradiation. The application of the formula is illustrated in the determination of aluminum and silicon in tungsten by nondestructive activation analysis. (auth)

8030 SIZE RELATION BETWEEN A CHROMATOGRAPHIC SPOT AND ITS AUTORADIOGRAM. **Aronoff, S. (Iowa State**

Univ., Ames); Suschny, O. Nature (London), 216: 1214-15(Dec. 23, 1967).

If a chromatogram has a number of spots representing a series of concentrations of a solute, with each member of the series containing an identical amount of radioisotopic solute, color development after chromatography gives the expected near-linear relation between the areas of the spots and the logarithms of their concentrations, but the corresponding autoradiogram shows spots of equal size. A simple explanation for this is given. (UK)

8031 SAMPLE INJECTION PORT FOR THE GAS–LIQUID CHROMATOGRAPHIC ANALYSIS OF IRRADIATED ORGANIC COMPOUNDS. Barakat, M. F. (Atomic Energy Establishment, Cairo). J. Sci. Instrum., 44: 1031(Dec. 1967).

A sample injection port specially suited for the gas-liquid chromatographic analysis of irradiated organic compounds is described. The nonvolatile portion of the injected sample is retained in the evaporation chamber, while volatile components pass over into the chromatographic column. After analysis the evaporation chamber can be easily opened, cleaned and then recovered to be ready for the subsequent analysis. Long term use of the reported device showed it to be satisfactory in use, and that there were no ill effects on peak shapes or on the quantitative analysis of samples. (auth) (UK)

8032 PLUTONIUM CONVERSION PROCESSES. Cleveland, J. M. (Dow Chemical Co., Golden, Colo.). pp 553-72 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Processes are described for the conversion of plutonium products in HNO_3 solutions to the metal. Plutonium conversion processes generally consist of two operations: conversion of the plutonium nitrate to a halide; and reduction of the halide to metal. Several alternate processes are in use for the halide preparation step, but only reduction with an active metal has been used for the conversion of the halide to metal on a production scale. Electrolytic processes for the preparation of high-purity metal are described, along with direct reduction of PuO_2. (P.C.H.)

8033 ANALYSIS. Brouns, Richard J. (Battelle Memorial Inst., Richland, Wash.). pp 707-48 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Methods for the analysis of plutonium and its principal alloys and compounds are described. Emphasis is on those methods and techniques that would probably be of particular interest to a laboratory engaged in plutonium metal and alloy production, fuel element fabrication, and the limited chemical processing that may be associated with such activities, such as scrap and waste recovery. Some of the methods discussed include: oxidation-reduction titration, electrometric methods, x-ray absorption and x-ray emission, spectrophotometry, complexometric titration, alpha counting, isotopic dilution, and spectrography. (336 references) (P.C.H.)

8034 RADIOCHEMICAL DETERMINATION OF PLUTONIUM FOR RADIOLOGICAL PURPOSES. Nielsen, J. M.; Beasley, T. M. (Battelle Memorial Inst., Richland, Wash.). pp 921-36 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

A review is presented on the techniques that have been and are currently being used for the determination of plutonium in diverse radiological samples. This includes radioisotopes of plutonium, dissolution of biological samples, isolation and purification of plutonium, and counting and statistics. (66 references) (P.C.H.)

8035 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR NEUTRON ACTIVATION ANALYSIS. Smith, George Donald; Mitchell, Frank Ronald Goodwin (to Plessey-Uk Ltd.). British Patent 1,094,702. Dec. 13, 1967. Filed Aug. 23, 1963.

An apparatus for neutron activation analysis includes dose measuring apparatus arranged to measure the total number of neutrons emitted by a neutron source during a given irradiation interval. The dose measuring apparatus includes a neutron detector arranged in fixed physical relationship with the source, means for integrating over the irradiation interval the neutron flux incident on the detector, and means for applying a correction to the quantity representing the integrated neutron flux to allow the decay during the irradiation interval of radiactivity resulting from the neutron bombardment and having a half-life of the same order as the irradiation interval. (B.L.M.)

8036 METHOD AND AN APPARATUS FOR THE RADIO GAS CHROMATOGRAPHIC ANALYSIS OF A MIXTURE OF DIFFERENT COMPONENTS. (to N. V. Philips' Gloeilampenfabrieken). British Patent 1,093,753. Dec. 6, 1967. Priority date Oct. 14, 1964, Netherlands.

A method for the radio-gas-chromatographic analysis of a mixture of different components comprises oxidizing the gaseous effluent from the chromatographic column and analyzing the components in a mass detector and in a radioactivity detector. ^{14}C may be employed as a tracer in the process. The apparatus comprises a combustion device and a mass detector connected on one hand to the gas chromatographic column, and, on the other hand, to the radioactivity detector. The combustion device and the mass detector are also combined into a flame ionization detector, which is so constructed that the combustion gases can be collected. (B.L.M.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 8019, 8120, 8132, 8156, 8724, and 10149.

8037 (COO–1008-3) DEUTERIUM AND TRITIUM EFFECTS ON THE RATES OF ORGANIC REACTIONS. Annual Technical Progress Report. (Indiana Univ. Foundation, Bloomington). Dec. 1967. Contract AT(11-1)-1008. 22p. Dep. CFSTI.

Research progress is reported on deuterium and tritium effects on the rates of organic reactions. Topics covered include: deuterium effects on solvolysis of isopropyl p-bromobenzenesulfonate, solvolytic α-deuterium effects for different leaving groups, deuterium effects on solvolysis of optically active α-phenylethyl chlorides, hydrogen participation in 2,6-dimethylcyclohexyl p-bromobenzenesulfonate solvolysis, α-deuterium effects on rates of solvolysis of some substituted benzyl halides and arenesulfonates, temperature and solvent dependence of isotope effects in the solvolysis of some 1-phenylethyl halides, mechanism and isotope effects in the solvolysis of some propargyl compounds, and β- and γ-deuterium effects on the solvolysis rate of pinacolyl brosylate. (M.C.G.)

8038 (COO–1684-2) CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS, FLASH HEATING OR FLASH PHOTOLYSIS. Technical Progress Report, February 1, 1967–October 31, 1967. Kay, Jack G. (Toledo Univ., Ohio. Dept. of Chemistry). Contract AT(11-1)-1684. 16p. Dep. CFSTI.

Progress is reported on the study of effects of flash heating on the surface of an alumina catalyst; study of $KMnO_4$ crystals and their decomposition due to flash photolysis and flash heating; flash heating and kinetic spectroscopy, manganese oxide problem; flash heating and kinetic spectroscopy, titanium monohalides; and chemical effects of nuclear transformations and annealing in inorganic crystals. (D.H.M.)

8039 (ORNL–4186) ^{137}Cs DATA SHEETS. Rimshaw, S. J.; Ketchen, E. E. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 27p. Dep. CFSTI.

Data on ^{137}Cs are tabulated. Properties of the fuel forms CsCl, Cs_2SO_4, and cesium borosilicate glass are given. (27 references) (M.C.G.)

8040 (ORNL–4187) CURIUM DATA SHEETS. Rimshaw, S. J.; Ketchen, E. E. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 52p. Dep. CFSTI.

Data on the fuel forms of ^{244}Cm are presented. Properties of ^{244}Cm metal, Cm_2O_3, Cm_2O_2S, CmF_3, ^{242}Cm, and $^{242}Cm_2O_3$ cermets are tabulated. (49 references) (M.C.G.)

8041 (ORNL–4203) X-RAY DIFFRACTION DATA ON THE SYSTEM CARBON TETRACHLORIDE–NEOPENTANE AT 0°C. Narten, A. H. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 27p. Dep. CFSTI.

The diffraction pattern of an equimolar $CCl_4-C(CH_3)_4$ mixture in equilibrium with its vapor has been measured at 0°C. The diffractometer used was specially designed for the study of liquid structure. Both the raw data and the intensity and radial distribution functions derived from them are presented in tabulated form. (auth)

8042 (ORO–2842-6) SUBSTITUTION IN OXYIONS. Annual Progress Report. Earley, Joseph E. (Georgetown Univ., Washington, D. C. Dept. of Chemistry). Jan. 15, 1968. Contract AT(40-1)-2842. 3p. Dep. CFSTI.

It was found that CO_2 is an efficient catalyst for the exchange of ^{18}O between $Cr(NH_3)_5OH^{2+}$ and solvent water. Furthermore, if the CO_2 is isotopically labeled and the solvent and $Cr(NH_3)_5OH^{2+}$ contain oxygen of normal isotopic abundance, the heavy isotope rapidly shows up on the $Cr(NH_3)_5OH^{2+}$. A complex of EDTA with $Cr(NH_3)_5OH^{2+}$ was detected and the reaction is being studied potentiometrically. (M.C.G.)

8043 (AEC-tr–6908, pp 6-9) NUMBER TRANSMISSION OF FAST ELECTRONS THROUGH FINITE SLABS OF CARBON

AND POLYSTYRENE. Nakai, Yohta; Matsuda, Kohji; Takagaki, Torao; Kimura, Ki-ichi. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 5-8(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19634.

8044 (ANL-Trans-546) POLYOXIDES OF FOUR AND SEVEN VALENT TECHNETIUM WITH ALKALINE EARTHS. Wassilopulos, Miltiades (Kernforschungszentrum, Karlsruhe (West Germany)). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report KFK-341. 70p. Dep. CFSTI. JCL $7.60 fs, $2.33 mf.

This report was abstracted previously from the original language and appeared in NSA as 20: 7050.

8045 (CEA-tr-R-1905) CHALEURS DE FORMATION DES FLUORURES D'URANIUM GAZEUX. (Heats of Formation of Gaseous Uranium Fluorides). Godnev, I. N.; Suerdlin, A. S. Translated into French from Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 9: 40-3(1966). 9p. (In French). Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The heats of formation of gaseous uranium fluorides, UF_n, are given for n = 1, 2, 3, 4, and 5. Equations are given for determining the values for UF_4. For the other fluorides, two methods were used. The first method was based on the construction of curves of heats of formation of gaseous fluorides, UF_n from F(gas) and U(gas) as a function of n. The second method was based on the construction of a curve of heats of dissociation or the thermal effects on the reaction at 298°K as a function of n. Data are tabulated and compared. (P.C.H.)

8046 (JPRS-42561) THERMAL DECOMPOSITION OF URANIUM OXIDES IN A VACUUM. Kozhina, I. I.; Shiryaeva, L. V.; Tolmachev, Yu. M. Translated from Vestn. Leningrad. Univ., Ser. Fiz. Khim., 22: 133-40(1967). 13p. (TT-67-33189). CFSTI.

The dissociation of U_3O_8 in a vacuum (10^{-4} to 10^{-5} mm Hg) was investigated in the temperature range from 300 to 900°C. Uranium oxides of different composition were subjected to chemical and x-ray analyses to establish phase ratios. The high-temperature x-ray investigation of uranium oxides was carried out in the temperature range from 300 to 1100°C. The rhombic phase resulting from the decomposition of U_3O_8 was established to be in the composition range of $UO_{2.662}$ to $UO_{2.605}$. Besides this phase there is a fluorite phase in the uranium oxides with a lesser oxygen index. (auth)

8047 STUDY BY DIFFERENTIAL THERMAL ANALYSIS OF THE EUTECTIC REACTION IN MAGNESIUM–YTTRIUM ALLOYS. Miannay, Dominique; Gregoire, Pierre; Azou, Pierre; Bastien, Paul (Ecole Centrale des Arts et Manufactures, Paris). Compt. Rend., Ser. C, 265: 1107-12(Nov. 13, 1967). (In French).

The application of differential thermal analysis to magnesium–yttrium alloys made it possible to determine exactly the lines in the equilibrium diagram relative to the eutectic reaction, the limit of the flat section, and the heat of reaction. (tr-auth)

8048 SYNTHESIS OF MONOCRYSTALS, TWIN CRYSTAL, AND SPATIAL GROUPING OF THE COMPOUNDS UTa_3O_{10}, UNb_3O_{10}, AND UV_3O_{10}. Chevalier, Raymond; Gasperin, Madeleine (CNRS, Paris). Compt. Rend., Ser. C, 265: 1101-3(Nov. 13, 1967). (In French).

The synthesis of three isostructural orthorhombic compounds of the spatial grouping F ddd is described. Their crystallographic values and the twin crystal with which they appear the most often are made evident by x-ray diffraction by means of a Weissenberg chamber or a precession chamber. (tr-auth)

8049 A SPECTROPHOTOMETRIC STUDY OF THE THORIUM COMPLEX OF 2-(1,8-DIHYDROXY-3, 6-DISULFO-2-NAPHTHYLAZO)-MANDELIC ACID. Miyata, Haruo (Okayama Univ., Japan). Bull. Chem. Soc. Jap., 40: 2815-18(Dec. 1967).

2-(1,8-Dihydroxy-3,6-disulfo-2-naphthylazo)mandelic acid formed a stable violet complex with thorium ion at 1 : 1 molar ratio in an acidic solution. The acid dissociation constants of the reagent and the apparent stability constant of its thorium complex were estimated spectrophotometrically at 25°C and $\mu = 0.1$. It was found that the thorium complex was more stable than those of previously reported phenyl-azo-chromotropic acid derivatives. (auth)

8050 ISOTOPE EFFECT IN DISSOCIATIVE RESONANCE-ELECTRON-CAPTURE (DREC) BY METHYLACETYLENE. Sugiura, Toshio; Seguchi, Tadao; Arakawa, Kazuo (Japan Atomic Energy Research Inst., Takasaki). Bull. Chem. Soc. Jap., 40: 2992-4(Dec. 1967).

A pronounced isotope effect was observed on $(M-X)^-$ ion formation (X indicates a hydrogen of deuterium atom) in DREC by three deutero-protio isomers of methylacetylene (CH_3CCH, CH_3CCD, and CD_3CCH), using a conventional ion source and a single focusing mass spectrometer. It was concluded that in DREC by methylacetylene, indexed as propyne, the probability of the loss of an acetylenic H (or D) atom is about three times greater than that of methylenic H (or D) atom, and that the isotope effect in scission probability of the C–X bond in DREC is about 13 times greater in the C–H bond than in the C–D bond in either acetylenic or methylenic C–X bond. (J.G.B.)

8051 DETERMINATION OF THE STABILITY CONSTANTS OF UO^{2+}_2, Ce^{3+}, Y^{3+}, Ni^{2+}, Cu^{2+}, AND Sr^{2+} COMPOUNDS WITH ACETIC ACID BY PAPER ELECTROPHORESIS. Marcu, Gheorghe; Botar, Alexandru. Stud. Univ. Babes-Bolyai, Ser. Chem., 12: No. 2, 11-17(1967). (In Rumanian).

Paper electrophoresis was used in studies on the formation of the acetates of U(VI), Ce(III), Y(III), Ni(II), Cu(II), and Sr(II). In the case of yttrium and strontium the ^{90}Y and ^{90}Sr radioisotopes were used. The experimental values of the stability constants are: $\lg\beta_{3(U)} = 5.61$, $\lg\beta_{2(Ce)} = 3.31$, $\lg\beta_{2(Y)} = 3.74$, $\lg\beta_{2(Ni)} = 3.64$, $\lg\beta_{2(Cu)} = 3.54$, and $\lg\beta_{2(Sr)} = 2.14$. The total and partial instability constants were calculated at the same time. The results showed again that the method of paper electrophoresis can be successfully applied for this purpose. (auth)

8052 MASS SPECTRA OF PYRIDINE AND PICOLINES. Tsuji, Kozo; Hayashi, Koichiro; Okamura, Seizo; Hatada, Motoyoshi; Hirota, Kozo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 97-102(1966-67). (In Japanese).

Mass spectra of pyridine and pentadeuterated pyridine were observed and fragment ions were identified. Mass spectra of three kinds of picolines were observed. A symmetric form of parent ion was proposed for the process $(93^+) \rightarrow (66^+) + 27$. Other mechanisms of fragmentation are also discussed. (auth)

8053 HIGH-TEMPERATURE BEHAVIOR OF BERYL AND BERYL MELTS AT HIGH PRESSURE. Munson, Ronald A. (General Electric Co., Schenectady, N. Y.). J. Amer. Ceram. Soc., 50: 669-70(Dec. 21, 1967).

The pressure dependence of the nonreversible thermal decomposition of natural beryl was examined between 15 and 50 kbars using the high-pressure "belt" apparatus. The principal products of decomposition are silica, phenacite, and chrysoberyl. As the pressure is increased the thermal stability of beryl decreases and the thermal stability of the decomposition products increases. Silica crystallizes from beryl melts as coesite at the higher pressures and as quartz at the lower pressures. (auth)

8054 LOGARITHMIC DISTRIBUTION COEFFICIENTS OF RARE EARTH COMPOUNDS FRACTIONALLY PRECIPITATED FROM HOMOGENEOUS SOLUTION. Firsching, F. H.; Aton, Guy W.; Bakowski, Ralph S.; Klotz, Marvin R.; Meggos, Haralambos N.; Melm, Gerald D.; Paul, Thomas R.; Smith, Michael J.; White, James D. (Southern Illinois Univ., Edwardsville). Anal. Chem., 40: 152-7(Jan. 1968).

A study of the fractional precipitation of the rare earth iodates from homogeneous solution using double complexation and replacement was made. The Doerner-Hoskins logarithmic distribution coefficient (lambda) was found for a variety of combinations of two rare earths and two complexing agents. Lambda values obtained using two complexing agents were compared with lambda values obtained using only one complexing agent. Additional lambda values were calculated from these experimentally determined values. A comparison of calculated and experimental values is in good agreement. Approximate lambda values were also computer calculated with a set of equations using solubility product and formation constant data. (auth)

8055 PRECISION STANDARDIZATION OF CERIC SULFATE SOLUTIONS. Zielen, A. J. (Argonne National Lab., Ill.). Anal. Chem.. 40: 139-45(Jan. 1968).

Standardization procedures for ceric sulfate solution accurate to 0.01% were verified by agreement between the National Bureau of Standards redox reagents: arsenious oxide, sodium oxalate, and potassium dichromate. Particular attention was paid to the catalyst role of osmium tetroxide in the As(III)–Ce(IV) reaction. Incomplete reoxidation of the osmium to the VIII state was found to cause serious errors. Depending on the amount of osmium, titration direction, and potentiometric vs. indicator end point detection, these errors ranged as high as 0.3 to 0.4% for a 2-meq sample. The only error-free method was found to be the potentiometric titration of Ce(IV) by As(III), which is the reverse of the customary procedure. The redox indicator ferroin can also be used if a blank correction is applied. A similar direction dependence was observed in the potentiometric standardization of

Fe(II) with dichromate. Here, dichromate as the titrating agent avoids a small error. (auth)

8056 SOL-GEL PROCESS. Kanij, J. B. W.; van der Plas, Th. Atoomenergie Haar Toepass, 9: 213-24(Oct. 1967). (In Dutch).

The sol-gel process has an important place in the fabrication of spherical fuel particles. A description is given of this process. Some other uses of the process are indicated. (tr-auth)

8057 EFFECT OF CRYSTALLOGRAPHIC ORIENTATION ON THE DISSOLUTION OF URANIUM DIOXIDE IN NITRIC ACID. Shabbir, M.; Robins, R. G. (Univ. of New South Wales, Kensington). J. Nucl. Mater., 25: 97-8(1968).

Results of etching experiments on polished polycrystalline UO_2 pellets indicated that over a range of nitric acid concentration from 1 to 37 molal there is a preferential attack on grains with $\{100\}$ parallel to the surface and comparatively little attack on grains with $\{111\}$ orientation. (M.C.G.)

8058 CATALYTIC DEUTERIUM EXCHANGE REACTIONS WITH ORGANICS. XXXI. ACCELERATIVE EFFECTS OF IONIZING RADIATION AND ULTRAVIOLET LIGHT ON SELF-ACTIVATED PLATINUM OXIDE. Garnett, J. L.; Rainis, A.; Wong, P. K. (Univ. of New South Wales, Kensington). Aust. J. Chem., 20: 2415-27(Nov. 1967).

The effect of preirradiation with γ rays from ^{60}Co and ultraviolet light from a low-pressure source on the exchange between benzene and heavy water in the presence of self-activated platinum oxide was studied. Both rates of multiple and stepwise exchange processes were accelerated under these conditions. Of 14 oxides examined, including the Group VIII transition metals, platinum was the only one to catalyse exchange up to 130°C. Preliminary experiments indicated that radioinduced oxygen desorption from the surface of the oxide was responsible for the accelerative effect. Internal radiation sources such as tritium oxide also increased initial exchange rates. Cholesterol, naphthalene, dibenzyl, diphenyl, benzoic acid, and diphenyl ether were studied with tritium oxide. The results can be rationalized in terms of π-complex mechanisms for exchange. A catalytic model for the mechanism of the radioinduced effect is proposed. (auth)

8059 KINETICS OF DEUTERIUM-NEOPENTANE EXCHANGE: EFFECTS OF DESORPTION AND DIFFUSION. Dwyer, F. G. (Univ. of Pennsylvania, Philadelphia); Eagleton, L. C.; Wei, J.; Zahner, J. C. Proc. Roy. Soc. (London), Ser. A, 302: 253-70(Jan. 2, 1968).

The product distribution of isomers from the deuterium exchange of neopentane over palladium supported on silica-alumina particles was found to be influenced by the competition among three rate processes: desorption, diffusion, and surface exchange. The theory based on a single-step surface mechanism is presented and given quantitative treatment, suitable for large conversions. The experimental results show a very wide variety of product distributions over the same catalyst, and can be quantitatively correlated by the theory. (auth) (UK)

8060 RARE GAS PHOTOSENSITIZED EXCHANGE REACTION BETWEEN HYDROGEN AND DEUTERIUM. von Buenau, Guenther; Schindler, Ralph N. (Max-Planck-Institut fuer Kohlenforschung, Muelheim, Ger. Kernforschungsanlage, Juelich, Ger.). pp 42-57 of International Conference on Photochemistry, Sept. 6-9, Munich. Part I and II. Munich, Max-Planck-Institut fuer Kohlenforschung, 1967.

See CONF-670954-(Pt. I and II).

Experiments on the rare gas-photosensitized atom exchange between hydrogen and deuterium provided strong evidence that excited krypton and xenon can efficiently transfer energy to hydrogen molecules and induce their dissociation into ground state atoms. Since 8.4-eV excitation energy is available in the xenon-sensitized experiments and 10.6-eV in irradiations with the krypton resonance lamp, formation of electronically excited hydrogen atoms can be excluded. From these figures an upper limit can be taken for the amount of kinetic energy carried away by hydrogen atoms generated in a primary act, namely 3.9 eV and 6.1 eV, respectively. It was evident from the experiments that heterogeneous HD formation was also operative. It was concluded that some chemical mechanism should be assumed to be responsible for the energy transfer observed in these sensitized exchange reactions. (D.H.M.)

8061 LATTICE CONSTANTS AND MELTING POINTS OF ACTINIDE-GROUP IVA-VIA COMPOUNDS WITH NaCl-TYPE STRUCTURES. Kruger, O. L; Moser, J. B. (Argonne National Lab., Ill.). J. Phys. Chem. Solids, 28: 2321-5(Nov. 1967).

Compounds of the actinides with group V and VI nonmetals were prepared by reaction of high-purity metals with the appropriate gases and by arc-fusion of the elements. Lattice constants and melting points of the compounds are reported. These properties were correlated with the electronic configuration of the actinides, and the position of the nonmetal component in the period table. (auth) (UK)

8062 THEORY OF ISOTOPIC COMPOSITION EFFECT IN THE SPECTRA OF IMPURITY CRYSTALS. Rebane, K. K.; Sild, O. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 222-6(Sept. 1967).

Translated from Opt. Spektrosk., 23: 414-20(Sept. 1967).

The effect of the isotopic composition of impurity centers in crystals on the electronic-vibrational spectral lines was investigated. The displacement of the purely electron line caused by replacement of atoms in the impurity center by isotopes was calculated along with the isotopic displacement in the repeated series of the purely electron line. The effect of anharmonic vibrations on the isotopic displacement of spectral lines was examined. The theoretical results were compared with experiment for the luminescence spectrum of the O_2^- center in KBr. (auth)

8063 STUDY OF THE EFFECT OF FOREIGN IONS ON THE COPRECIPITATION OF MOLYBDENUM AND TUNGSTEN WITH ZIRCONIUM HYDROXIDE. Plotnikov, V. I.; Kochetkov, V. L. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 53-7 (July-Aug. 1967). (In Russian).

The effects of some anions on the coprecipitation of Mo and W with zirconium hydroxide were investigated. The desorption of Mo and W increased in the presence of foreign ions in the series SO_4^{2-}; $SO_3^{2-} < BO_3^{3-} < CrO_4^{2-} < CO_3^{2-} < SeO_3^{2-} < AsO_3^{3-} < PO_4^{3-}$. At equal concentrations in the solution the coprecipitation of the anions studied with zirconium hydroxide increased in the following series $CrO_4^{2-} < MoO_4^{2-} < SeO_3^{2-} < WO_4^{2-} < PO_4^{3-}$. (tr-auth)

8064 DETERMINATION OF THE EQUILIBRIUM CONSTANT OF ISOTOPE EXCHANGE BY N. M. R. MEASUREMENTS. Neszmelyi, A.; Simonyi, M.; Tudos, F. (Central Research Inst. for Chemistry, Budapest). Acta Chim. Acad. Sci. Hung., 53: 369-73(1967).

In the NMR spectrum of the system water—hydroquinone—acetone of suitable concentration the water content and the phenol content of the mixture are measurable simultaneously. In the solution of hydroquinone and heavy water, equilibrium is rapidly attained at room temperature. On basis of the two equilibrium concentrations, the conversion and the concentrations of the other components can also be determined. The equilibrium constant $K = 0.90 \pm 0.11$ was found in excellent agreement with the partition ratio determined by C. K. Ingold for phenol. (auth)

8065 CRYSTAL STRUCTURES AND LATTICE PARAMETERS OF THE COMPOUNDS OF BERKELIUM. III. BERKELIUM OXYCHLORIDE. Peterson, J. R.; Cunningham, B. B. (Univ. of California, Berkeley). Inorg. Nucl. Chem. Lett., 3: 579-83(Dec. 1967). (UCRL-17766).

Studies are reported on PbFCl-type tetragonal BkOCl. The method of preparation from $BkCl_3$ is described, and results are tabulated. Corrections were made for known Ce and Cf contents of the Bk. Best estimates for pure BkOCl were $a_0 = 3.966 \pm 0.004$ Å, $c_0 = 6.710 \pm 0.009$ Å. The tabulated data include partial line lists and indexing, calculated 2 Θ values, and observed and calculated line intensities. A plot is included of the molecular volumes of the PbFCl-type actinide and lanthanide cychlorides; with the exception of UOCl the correlation is good, showing familiar contractions in the lanthanide and actinide series. The calculated x-ray density of BkOCl is 9.45 g/cc. Anion crowding is very severe in the structure; the O—O distance is 2.80 Å, the Cl—Cl distance 3.34 Å, the Bk—O distance 2.32 Å, and the Bk—Cl distances 3.07 Å (four nearest neighbours) and 3.05 Å (one nearest neighbour). Both anion—anion distances are considerably smaller than twice the crystal radii given by Zachariasen for O^{2-} (1.46 Å) and Cl^- (1.81 Å). Different values are obtained for the Bk^{3+} radius from the Bk—Cl and Bk—O distances, illustrating the limitations of the ionic radius concept. (UK)

8066 HYDROLYSIS OF THE HEXAHALOGEN TECHNETATES (IV). NOTE I. BEHAVIOR OF THE $TcBr_6^{2-}$ ION IN ACID, NEUTRAL, AND ALKALINE SOLUTIONS. Ossicini, Luigia (Univ. Rome. CNR, Rome). Ric. Sci., 37: 655-9(July-Aug. 1967). (In Italian).

Hexabromotechnetate(IV) hydrolyses in dilute HBr forming a cationic bromocomplex in water and alkali to yield first TeO_2 and then pertechnetate(VII). The species formed were examined by ion exchange chromatography, electrophoresis, and spectrophotometry. (auth)

8067 INFRARED SPECTRA AND NORMAL COORDINATE CALCULATION OF CRYSTALLINE FORMIC ACID. Mikawa, Y.; Brasch, J. W.; Jakobsen, R. J. (Battelle Memorial Inst., Columbus, Ohio). J. Mol. Spectros., 24: 314-29(1967).

Infrared spectra from 3000 to 70 cm^{-1} were obtained on the β-polymorphs of $(HCOOH)_n$, $(DCOOH)_n$, and $(HCOOD)_n$ crystals. All of the observed absorption bands were assigned on the basis of an infinite hydrogen bonded chain having a factor group isomorphous to $C_{2\nu}$. In order to verify the assignment, normal coordinate calculations were carried out for $(HCOOH)_n$ with a set of force constants obtained from the observed frequencies. These force constants were successfully used to predict the frequencies of $(DCOOH)_n$ and $(HCOOD)_n$. Both the potential energy distribution and Cartesian displacements were calculated in order to accurately determine the modes of the vibrations, including the hydrogen bond vibrations. This represents the first successful calculation for a hydrogen bonded polymeric molecule in which the modes of the hydrogen bond vibration were reasonably determined. (auth)

8068 THERMAL ANALYSIS OF THE TERNARY SYSTEMS $AlCl_3-SnCl_4(ZrCl_4, HfCl_4)-POCl_3$. Voitovich, B. A.; Barabanova, A. S. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh., 33: 1018-24(1967). (In Russian).

Thermal analysis of the system $AlCl_3-SnCl_4-POCl_3$ showed that $SnCl_4$ with $AlCl_3$ forms a eutectic-type diagram. The constitution diagram of the system $AlCl_3-SnCl-POCl_3$ consisted of six fields of crystallization: $AlCl_3$, $POCl_3$, $SnCl_4$, $AlCl_3 \cdot POCl_3$, $2AlCl_3 \cdot 3POCl_3$, and $SnCl_4 \cdot 2POCl_3$. Studies of the binary cross sections of $AlCl_3 \cdot POCl_3-ZrCl_4 \cdot 2POCl_3$ and $AlCl_3 \cdot POCl_3-HfCl_4-2POCl_3$ showed that in the systems $AlCl_3-ZrCl_4-POCl_3$ and $AlCl_3-HfCl_4-POCl_3$ ternary compounds of the $AlCl_3 \cdot Zr(Hf)Cl_4 \cdot 3POCl_3$ type do not exist. (R.V.J.)

8069 CATALYSIS OF α-HYDROGEN EXCHANGE. VII. ISOBUTYRALDEHYDE-2-d EXCHANGE IN THE PRESENCE OF PRIMARY AMINE SALTS AND PYRIDINE BUFFERS. Hine, Jack; Menon, B. C.; Mulders, Julien; Idoux, John P. (Ohio State Univ., Columbus. Georgia Inst. of Tech., Atlanta). J. Org. Chem., 32: 3850-3(Dec. 1967).

The dedeuteration of isobutyraldehyde-2-d was studied in the presence of pyridine buffers and the hydrochlorides of ten different primary amines. The principal term in the kinetic equation has the form $k[Me_2CDCHO][C_5H_5N][RNH_3^+]$ and is believed to be due to the rate-controlling attack of pyridine on N-isobutylidene-alkylammonium ions present in equilibrium with aldehyde and alkylammonium ions. With RNH_3^+ such that R is primary, the catalytic efficiency tends to increase with increasing acidity (decreasing basicity of RNH_2), but isopropyl- and t-butylammonium ions are less reactive than would be expected from their acidities. The effect of the structure of R on the reactivity is discussed in terms of the hybridization of and the charge on the nitrogen atom to which R is attached in the alkylammonium ion, the imine, and the transition state of the rate-controlling step and also in terms of steric factors. (auth)

8070 CONFORMATIONAL ANALYSIS. I. THE RELATIVE SIZE OF METHYL AND METHYL-d_3 GROUPS. Coke, James L.; Mourning, Michael C. (Univ. of North Carolina, Chapel Hill). J. Org. Chem., 32: 4063-4(Dec. 1967).

The relative size of deuterium and hydrogen in an equilibrium reaction in a case where hyperconjugative effects could be excluded was examined. The relative sizes of a methyl and methyl-d_3 group were examined in a steric situation that involved equilibration between the axial and equatorial 2 position of 4-tert-butylcyclohexanone. The difference observed was at the limits of experimental error. (M.C.G.)

8071 THE ^{14}C ISOTOPE EFFECT IN THE DECOMPOSITION OF p-NITROPHENETHYL-1-^{14}C-TRIMETHYLAMMONIUM IODIDE. Hodnett, Ernest M.; Dunn III, William J. (Oklahoma State Univ., Stillwater). Contract AT(11-1)-1049. J. Org. Chem., 32: 4116(Dec. 1967).

An isotope effect K^*/K of 0.928 was observed for the decomposition of ^{14}C-labeled p-nitrophenethyltrimethylammonium iodide. This is advanced as evidence that the carbon–nitrogen bond is broken. (M.C.G.)

8072 FORMATION OF COMPLEXES OF HEXAVALENT PLUTONIUM WITH PHOSPHATES. Denotkina, R. G.; Shevchenko, V. B. Zh. Neorg. Khim, 12: 2345-50(Sept. 1967). (In Russian).

In phosphoric acid solutions with concentrations of H_3PO_4 equal to 0.02 to 5.88 mol/l, two complex ions exist: $[PuO_2H_2PO_4]^+$ and $[PuO_2(H_2PO_4)_2]^0$. The complex plutonyl ion $[PuO_2H_2PO_4]^+$ is formed in the phosphoric acid concentration range from 0.02 to 0.206 mol/l. In solution with concentrations of H_3PO_4 greater than 0.206 mol/l the neutral complex compound is formed with the ratio PuO_2^{2+} : addend = 1 : 2. The instability constant of the complex cation $[PuO_2H_2PO_4]^+$ is equal to 1.18×10^{-4}. (tr-auth)

8073 REACTIONS OF $ThCl_4$ WITH SODIUM AND POTASSIUM SELENOCYANATES IN ANHYDROUS SOLUTIONS. Golub, A. M.; Kalibabchuk, V. A. Zh. Neorg. Khim, 12: 2370-6(Sept. 1967). (In Russian).

The interaction of $ThCl_4$ with sodium and potassium selenocyanates was investigated in acetone and dimethylformamide (DMF). The formation of complexes of thorium containing from 1 to 6 SeCN groups was established in the solutions. The equilibrium constants of the formation reactions of the thorium selenocyanate complexes were calculated from spectrophotometric data. It was shown that their stability increases in the transition from DMF to acetone. These complexes are less stable than the thiocyanates. It was established that formation of the selenocyanate complexes of thorium depends on the nature of the external ring of the cation. In the presence of potassium ions the more complex anion complex $(Th(NCSe)_8^{4-})$ was formed somewhat easier than in the presence of sodium ions. The following coordination compounds were obtained in the crystalline form: $Th(NCSe)_4 \cdot 4DMF$, $Na_2Th(NCSe)_6 \cdot 3DMF$, $K_2Th(NCSe)_6 \cdot 4.5DMF$, $K_4Th(NCSe)_8 \cdot 2DMF$. The coordination of the selenocyanate group around Th by means of bonds through N was established by the ir spectroscopy method. The bond of the DMF molecule with Th atoms is realized through oxygen atoms. (tr-auth)

8074 PROPERTIES OF COMPLEX AQUOSULFITE COMPOUNDS. Golovnya, V. A.; Molodkin, A. K.; Tverdokhlebov, V. N. Zh. Neorg. Khim, 12: 2377-87(Sept. 1967). (In Russian).

By differential thermal analysis and thermogravimetric methods and consideration of ir and NMR spectrometry, the thermal stabilities of the following thorium compounds were studied: $Th(SO_3)_2 \cdot 4H_2O$, $Me_2Th(SO_3)_3 \cdot \underline{n}H_2O$ (Me = K^+, Na^+, $CN_3H_6^+$), $Na_4Th_2(SO_3)_7 \cdot 18H_2O$, and $Me_4Th(SO_3)_4 \cdot \underline{n}H_2O$ (Me = Na^+ and NH_4^+). Schemes for thermal decomposition of these compounds were proposed. The formation of thorium sulfate as an intermediate product was established. Establishment of the character of the bonds of the four water molecules in thorium disulfite made it possible to consider them all intraspherical. On the basis of this, thorium aquodisulfite was qualified as the complex nonelectrolyte $[Th(SO_3)_2(H_2O)_4]$. The results of the thermal analysis and the ir and NMR spectroscopy agreed with the following coordination formulas of the trisulfite compounds: $K_2[Th(SO_3)_3(H_2O)_2] \cdot 5.5H_2O$, $Na_2[Th(SO_3)_3(H_2O)_2] \cdot 3H_2O$, $(CN_3H_6)_2[Th(SO_3)_3(H_2O)_2] \cdot 10H_2O$, and $(NH_4)_2[Th(SO_3)_3(H_2O)_2] \cdot 2H_2O$. In these compounds anion diaquotrisulfite complexes of thorium result. On the basis of the increased stability of the bond of one water molecule in the aquotetrasulfite thorates it was concluded that in these compounds one of the water molecules enters in the inner sphere, that is, the composition of the anion obeys the formula $[Th(SO_3)_4H_2O]^{4-}$. From the experimental data the nonuniformity of the coordination number of thorium in its sulfite compounds was found. In the tetraaquodisulfite and diaquotrisulfite, under two-pronged conditions of the sulfite group, it equals 8. In tetrasulfite compounds, the thorium coordination number with maintenance of the two-prong condition of the sulfite group is at least 9. With the tendency to hydrolysis and with the instability to the effect of acid, the sulfite complexes of thorium are nearer its carbonato complexes than the sulfato or oxalato complexes. (tr-auth)

8075 DETERMINATION OF THE FORMATION FUNCTION OF COMPLEX COMPOUNDS IN THE $UO_2^{2-}-C_2O_4^{2+}$ SYSTEM. Stepanov, A. V.; Makarova, T. P. Zh. Neorg. Khim, 12: 2395-2400(Sept. 1967). (In Russian).

It was shown that the velocity of electromigration of the auxiliary metal, introduced into the system studied, can be criterion of conformity of the solutions. By the method of corresponding solutions with the use of cerium as an auxiliary metal, the formation function, the composition, and the stability constants of the complex compounds in the U(VI)–oxalic acid system were determined. The results obtained agree well with electromigration determinations. The relation between formation function and total velocities of the electromigrations of the metal were determined and experimentally verified. (tr-auth)

8076 COMPLEX COMPOUNDS OF TITANIUM(IV), TIN(IV), AND THORIUM IN AROMATIC AND HETEROCYCLIC AZOMETHINES. Garnovskii, A. D.; Minkin, V. I.; Osipov, O. A.; Panyushkin, V. T.; Isaeva, L. K.; Knyazhanskii, M. I. Zh. Neorg. Khim, 12: 2443-8(Sept. 1967). (In Russian).

The reaction for the formation of complex salts of Ti(IV), Sn(IV), and Th(IV) with aromatic and heterocyclic azomethines, containing some donor centers, was investigated. The relations between the electron structure of the azomethine and the position of the coordination in the complexes formed were examined. (tr-auth)

8077 INVESTIGATION OF THE FORMATION OF THE COMPLEX OF THORIUM(IV) WITH N-CINNAMOYLPHENYLHYDROXYLAMINE BY THE DISTRIBUTION METHOD. Zharovskii, F. G.; Sukhomlin, R. N.; Ostrovskaya, M. S. Zh. Neorg. Khim, 12: 2476-80(Sept. 1967). (In Russian).

The extraction of thorium(IV) N-cinnamoylphenylhydroxylamine (CPHA) with chloroform was studied as a function of the thorium(IV) concentration, pH of the aqueous phase, and concentration of the CPHA in the chloroform. The extraction of thorium with the CPHA in solution in benzene was studied as a function of the pH. In the $CHCl_3-H_2O$ system, the stability constants of the complexes of Th(IV) with CPHA were determined as $\beta_1 = 5.8 \times 10^{12}$, $\beta_2 = 5.0 \times 10^{24}$, and $\beta_3 = 5.2 \times 10^{35}$ and the two-phase stability constant as $\lambda_4\beta_4 = 1.6 \times 10^{49}$. All constants were obtained at an ion strength of 0.1 and temperature of 20°C. (tr-auth)

8078 TETRAFLUORIDE COMPLEX OF URANYL IN NaCl–KCl–NaF MELTS. Koryushin, A. P.; Smirnov, M. V.; Komarov, V. E. Zh. Neorg. Khim, 12: 2511-3(Sept. 1967). (In Russian).

It was shown that in the fluoride–chloride melt NaCl–KCl–NaF uranyl formed the fluoride complex $UO_2F_4^{2-}$ with the ratio $|F|/|U| \gg 13$. The expression for the temperature dependence of the instability constants of the complex was found. (tr-auth)

8079 THE CORRELATION OF SECONDARY α-DEUTERIUM ISOTOPE EFFECTS WITH PRIMARY NITROGEN ISOTOPE EFFECTS IN THE THERMOLYSIS OF AZO COMPOUNDS. Seltzer, Stanley; Mylonakis, Stamatios G. (Brookhaven National Lab., Upton, N. Y.). J. Amer. Chem. Soc., 89: 6584-9(Dec. 6, 1967). (BNL-11638).

Nitrogen-15 isotope effects are reported for three aralkyl azo compounds that undergo thermal decomposition by three different mechanisms. The nitrogen effects, combined with the previously reported ^{13}C and secondary α-deuterium effects, are used to calculate the force field changes that take place for each reactant molecule on conversion to its activated complex. For bonds that are only slightly weakened (or tightened) in the transition state, self-consistent force fields are formed when the relative reduction (or increase) in the stretching and bending reactant force constants are the same. (auth)

8080 SECONDARY DEUTERIUM ISOTOPE EFFECTS. β-KINETIC EFFECTS IN Sn2 REACTIONS OF N,N-DIMETHYLANILINE AND DIMETHYLPHENYLPHOSPHINE WITH METHYL p-TOLUENESULFONATE AND COMPARISON WITH OBSERVED AND CALCULATED VIBRATIONAL FREQUENCIES OF DEUTERATED AND UNDEUTERATED DIMETHYLANILINE AND TRIMETHYLANILINIUM ION. Kaplan, Elizabeth D.; Thornton, Edward R. (Univ. of Pennsylvania, Philadelphia). J. Amer. Chem. Soc., 89: 6644-51(Dec. 6, 1967).

The rates of reaction, in nitrobenzene at 51.29°C, of methyl p-toluenesulfonate with N,N-dimethylaniline and N,N-dimethyl-d_6-aniline to form trimethylphenylammonium and methyldimethyl-d_6-phenylammonium p-toluenesulfonates, respectively, and with dimethylphenylphosphine and dimethyl-d_6-phenylphosphine to form the corresponding phosphonium salts, were determined conductiometrically. The secondary isotope effects observed were small and inverse: 1.133 ± 0.008 for the amines, and 1.050 ± 0.002 for the phosphines. The result for the amines is discussed in relation to the equilibrium isotope effect calculated using information obtained from the observed infrared spectra of the reactants and products. Though uncertainties in the assignment of spectral bands exist, it appears that there is very little shift in CH(CD) stretching force constants. The inverse effect is, therefore, very probably due to increased force constants for lower frequency vibrations, such as for bending. This interpretation is consistent with a steric explanation for the isotope effects. Inductive effects are expected to produce changes in the stretching force constants. (auth)

8081 KINETICS OF HYDROGEN ISOTOPIC EXCHANGE BETWEEN HCl AND DBr. SOLUTIONS IN LIQUID NITROGEN AND OXYGEN. Denisov, G. S.; Ryl'tsev, E. V. (Leningrad State Univ.). Teor. Eksp. Khim., 3: 701-5(Sept.-Oct. 1967). (In Russian).

Kinetics of isotopic exchange between hydrogen chloride and deuterium bromide dissolved in liquid nitrogen and oxygen were studied. These solutions being highly transparent in the infrared region, the absorption bands of HCl and DBr could be observed even at hydrogen halide solubility of 10^{-3} to 10^{-4} mole/l. The kinetics of the process were followed by observing the changes in the absorption band intensity ν(HCl), ν(HBr), ν(DCl), and ν(DBr) with time. (R.V.J.)

8082 EVIDENCE FOR THE EXISTENCE OF PROTACTINIUM(III) IN SOLID STATE. Scherer, V.; Weigel, F.; Van Ghemen, M. (Univ., Munich. Arizona State Univ., Tempe). Inorg. Nucl. Chem. Lett., 3: 589-95(Dec. 1967).

Evidence for the existence of PaI_3 was obtained. The thermal decomposition of PaI_5 was studied using mass spectrometric techniques, and it was found that the decomposition, in its first step, apparently follows the reaction $PaI_5 \xrightarrow{300°C} PaI_3 + I_2$. The evolved iodine was detected in the mass spectrometer, and the PaI_3 identified by its x-ray powder pattern. Experimental details are described, the mass spectrometric decomposition curve is reproduced, and powder pattern data are tabulated. The powder pattern was indexed on the basis of the data given for CeI_3 in the ASTM card catalogue. The lattice was orthorhombic, and the lattice constants fitted smoothly into those of the other actinide(III) iodides. Molecular volume data are given. Evidence for the existence of PaI_3 is discussed, but it is recognized that the identification still remains questionable. (UK)

8083 ISOTOPE EFFECT IN THE HIGH TEMPERATURE PHASE TRANSITION OF KH_2PO_4. Grinberg, J. (Univ. of Tel-Aviv, Israel); Levin, S.; Pelah, I.; Wiener, E. Solid State Commun., 5: 863-5(Nov. 1967).

Phase transitions were found at high temperatures in KH_2PO_4 and KD_2PO_4 according to the theory suggested by Pelah et al. Sharp changes in the dielectric constant and in the ir spectrum were observed at the transition points. At the same time, the crystal became opaque but no significant change in the crystal's weight was seen. Data on isotope effects are presented. (auth) (UK)

8084 COMPLEXES OF URANIUM(VI) WITH N-HYDROXYETHYL ETHYLENE-DIAMINETRIACETIC ACID AND ETHYLENEGLYCOL BIS(2-AMINOETHYL) ETHER TETRAACETIC ACID. Bhat, T. R.; Rao, T. Venkateswara (Atomic Energy Establishment, Bombay). Z. Anorg. Allg. Chem., 354: 201-7 (Oct. 1967).

Detailed investigations were carried out on the reaction of the uranyl ion with N-hydroxyethylethylenediaminetriacetic acid (indexed as — [ethylenebis(oxyethylenenitrilo)]tetraacetic acid) and ethyleneglycolbis(2-aminoethyl) ether tetraacetic acid (indexed as as — N-(carboxymethyl)-N′-(2-hydroxyethyl)-N,N′-ethylenediglycine) by potentiometric and spectrophotometric methods. Evidence is presented for the formation of 1 : 1 and 2 : 1 complexes and the corresponding hydroxy species. The formation constants of all these species were determined by a spectrophotometric method. (auth)

8085 DROP EXTRACTION BETWEEN LIQUID METALS AND FUSED SALTS. Olander, Donald R. (EURATOM, Ispra, Italy). Nucl. Sci. Eng., 31: 1-18(1968).

Extraction of ^{65}Zn from falling liquid-metal drops of pure zinc and dilute zinc in lead alloys by fused-salt solutions of lead chloride and zinc chloride in the potassium chloride–lithium chloride eutectic was investigated. Both chemical and isotopic exchange processes were found to be controlled by external mass transfer in the salt phase. The measured external resistances were comparable to those predicted by models based upon a rigid drop. Extraction in the pure zinc metal-lead chloride system appeared to proceed by a mechanism involving subchlorides as intermediates in the interfacial reaction. (auth)

8086 COATING COMPOSITIONS OF POLYETHYLENE GRAFT COPOLYMERS. Young, Lewis John; Burkholder, Joseph Elmer (to Dow Chemical Co.). British Patent 1,094,820. Dec. 13, 1967. Filed July 19, 1965.

The preparation of a thermoplastic coating having improved flowability and excellent corrosion resistance and adherence to to metals is described. The composition is from 10 to 75 wt % of polyethylene resins having an average molecular weight ranging from 1500 to 10,000 as determined by a melt viscosity method with a graft copolymer consisting of from 2 to 25 wt % of acrylic acid or methacrylic acid and from 98 to 75 wt % of polyethylene per 100 parts by weight of the graft copolymer. The final composition has a flow viscosity of from 20 to 11,000 poises as measured at a temperature of 225°C and a pressure of 700,000 dynes/cm^2. (B.L.M.)

Radiation and Nuclear Chemistry

Refer also to abstract 8562.

8087 (COO-1580-3) CONTROLLED POLYMERIZATION OF ADSORBED MONOMERS. Technical Progress Report. Livingston, H. K. (Wayne State Univ., Detroit, Mich. Dept. of Chemistry). Dec. 27, 1967. Contract AT(11-1)-1580. 28p. Dep. CFSTI.

The state of the art of adsorption polymerization is reviewed. The irradiation of furam molecules adsorbed on graphitized carbon black is described. A Langmuir surface balance for studying insoluble monolayers on water was used to prepare built-up monolayers of a polymerizable long-chain acid. (49 references). (M.C.G.)

8088 (NYO-3753-3) THE NATURE OF OXYGEN CONTAINING RADICALS IN RADIATION CHEMISTRY AND PHOTO-

CHEMISTRY OF AQUEOUS SOLUTIONS. Period Covered: September 1, 1967–July 1, 1968. Czapski, Gideon (Hebrew Univ., Jerusalem (Israel). Dept. of Physical Chemistry). Contract AT(30-1)-3753. 40p. Dep. CFSTI.

The known properties of oxygen-containing species in irradiated aqueous solutions are summarized. The HO_2 radical was found to exist in 3 forms in the pH range from 0 to 7. O_3^- was found in alkaline solutions. The OH^- radical is shown to exist in 2 forms with its pK = 11.8. Its absorption in the ultraviolet has a shoulder around 2600Å. It is shown that H_2O_2 is formed from recombination of HO_2 and OH radicals in acid solutions. (60 references). (M.C.G.)

8089 (AEC-tr–6908) ANNUAL REPORT OF THE JAPANESE ASSOCIATION FOR RADIATION RESEARCH ON POLYMERS, VOLUME 7, 1965–1966. Translation of Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, Volume 7, 1965–1966. 263p. Dep. CFSTI. JCL $17.00 fs, $8.24 mf.

Twenty-six papers are included and separate abstracts were prepared for 24 of the papers. The two remaining papers covered nuclear magnetic resonance studies of tetraoxane and the molecular orbital theory of mass spectra. Twenty-two of these papers were abstracted from the original language and appeared as 21: 19634 and 19687 to 19707, inclusive. (M.C.G.)

For abstracts of individual papers see: 8043 and 8090–8112.

8090 (AEC-tr–6908, pp 10-17) MULTIPLICATION OF COMPTON ELECTRONS IN POLYETHYLENE. Matsuda, Kohji; Nakai, Yohta; Kimura, Ki-ichi. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 9-15(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19687.

8091 (AEC-tr–6908, pp 18-24) SOME PROBLEMS ON THE GRAFTING OF FIBERS. Sakurada, Ichiro. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 17-23(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19688.

8092 (AEC-tr–6908, pp 25-32) SMALL ANGLE X-RAY STUDIES ON POLYETHYLENE OBTAINED BY GASEOUS-PHASE POLYMERIZATION OF ETHYLENE. Suzuki, Yasuo; Sakurada, Ichiro. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 25-32(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19689.

8093 (AEC-tr–6908, pp 33-41) OXYGEN UPTAKE DURING THE IRRADIATION OF POLYMERS IN AIR. Kimura, Fujiko; Sakurada, Ichiro. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 33-40(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19690.

8094 (AEC-tr–6908, pp 42-7) STUDIES ON POLYOXYMETHYLENE. IV. GRAFT COPOLYMERIZATION OF STYRENE ONTO POLYOXYMETHYLENE. Kimura, Fujiko; Yamuchi, Michiyo; Sakurada, Ichiro. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 41-5(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19691.

8095 (AEC-tr–6908, pp 48-55) STUDIES ON POLYOXYMETHYLENE. V. DEGRADATION OF STYRENE GRAFTED POLYOXYMETHYLENE. Kimura, Fujiko; Suzuki, Yasuo; Yamauchi, Michiyo; Sakurada, Ichiro. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 47-53(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19692.

8096 (AEC-tr-6908, pp 56-63) STUDIES ON RADIATION-INDUCED POLYMERIZATIONS OF α-OLEFINES. I. POLYMERIZATION OF ISOBUTENE. Ueno, Katsuji; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 55-60(1965-1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19693.

8097 (AEC-tr-6908, pp 64-73) STUDIES ON RADIATION-INDUCED POLYMERIZATIONS OF α-OLEFINES. II. POLYMERIZATION OF 3-METHYL BUTENE-1 AND 4-METHYL PENTENE-1. Kennedy, J. P.; Ueno, Katsuji; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 61-9(1965-1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19694.

8098 (AEC-tr-6908, pp 74-8) STUDIES ON RADIATION-INDUCED POLYMERIZATIONS OF α-OLEFINES. III. COPOLYMERIZATION OF α-OLEFINES WITH SULFUR DIOXIDE. Ueno, Katsuji; Shinkawa, Akihiro; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 71-4(1965-1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19695.

8099 (AEC-tr-6908, pp 79-96) STUDIES ON RADIATION-INDUCED IONIC POLYMERIZATION OF STYRENE. V. FREE ION MECHANISM ON POLYMERIZATION OF STYRENE. Ueno, Katsuji; Williams, Ffrancon; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 75-87(1965 – 1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19696.

8100 (AEC-tr-6908, pp 97-116) THE STUDY OF RADIATION-INDUCED IONIC REACTION BY ELECTRICAL CONDUCTIVITY MEASUREMENT. III. STYRENE, α-METHYL-STYRENE AND ISOBUTYL VINYL ETHER. Yamazawa, Yuzo; Takagaki, Torao; Hayashi, Kanae; Williams, Ffrancon; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 89-103(1965 – 1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19697.

8101 (AEC-tr–6908, pp 117-29) RADIATION-INDUCED POLYMERIZATION BY FREE IONS. PART 3. RATE CONSTANTS FOR CATIONIC POLYMERIZATION. Williams, Ffrancon; Hayashi, Kanae; Ueno, Katsuji; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 105-18(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19698.

8102 (AEC-tr-6908, pp 130-8) TRAPPED ELECTRONS IN γ-IRRADIATED 3-METHYLPENTANE. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 119-25(1965 – 1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19699.

8103 (AEC-tr–6908, pp 139-44) ESR STUDY ON IRRADIATED PYRIDINE: EFFECT OF IODINE ADDITION. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 127-31(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19700.

8104 (AEC-tr–6908, pp 145-53) ESR STUDY ON IRRADIATED MONOMER AND POLYMER OF 3,3-BIS (CHLOROMETHYL) OXETANE. Tsuji, Kozo; Iwamoto, Takeo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 133-40(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19701.

8105 (AEC-tr–6908, pp 154-6) ESR STUDY ON RADIATION-INDUCED POLYMERIZATION OF ISOBUTENE. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 141-3(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19702.

8106 (AEC-tr–6908, pp 157-72) STUDIES ON RADIATION-INDUCED POLYMERIZATION BY ELECTRONIC SPECTROSCOPY. 1. ABSORPTION SPECTRA OF IRRADIATED NITROETHYLENE AT THE LOW TEMPERATURE GLASSY STATE. Kamiyama, Hideo; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 145-57(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19703.

8107 (AEC-tr–6908, pp 173-82) THE MECHANISM OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF TRIOXANE STUDIES BY POLARIZED LIGHT MICROSCOPY AND ELECTRON MICROSCOPY. Nishii, Masanobu; Hayashi, Koichiro; Okamura, Seizo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 159-67(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19704.

8108 (AEC-tr–6908, pp 198-200) G VALUES OF METHYL RADICAL IN THE RADIOLYSIS OF PARAFFINE. Isoya, Toshiro; Hirota, Kozo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 181-2(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19705.

8109 (AEC-tr-6908, pp 201-10) IONIZATION AND DISSOCIATION OF ALIPHATIC ETHERS UNDER ELECTRON IMPACT. Takezaki, Jun'ichi; Hirota, Kozo; Hatada, Motoyoshi. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 183-91(1965–1966).

Ionization potentials of ten aliphatic ethers and their positive charge distributions of each bond just after the moment of electron impact were calculated by the LCMO method. The calculated positive charge distributions showed a good correlation to the scission probabilities of the corresponding bond obtained from mass spectra, while the calculated ionization potentials did not change so much. (auth)

8110 (AEC-tr-6908, pp 211-15) IDENTIFICATION OF THE IONS PRODUCED FROM METHYL ETHYL ETHER-d_3 BY ELECTRON IMPACT. Takezaki, Jun'ichi; Hirota, Kozo. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 193-7 (1965–1966).

Mass spectra of several aliphatic ethers, measured by a high-resolution mass spectrometer of the double-focusing type, were previously reported and an attempt was made to determine the probability of their bond scissions. However, it was not obvious in methyl ethyl ether (MEE) whether the CH_3^+ ion was produced from C−O bond scission or C−G bond scission. The ratio of CH_3^+ ion was produced from C−O bond scission to that from the C−C bond scission could not be calculated for MEE, because it is difficult to distinguish both kinds of the CH_3^+ ion mentioned above. To solve this problem, MEE-d_3 was synthesized, its mass spectrum was measured, and the ions produced were identified quantitatively. (auth)

8111 (AEC-tr-6908, pp 216-36) ESR STUDY OF IRRADIATED ORGANIC PHOSPHORUS COMPOUNDS AT LOW TEMPERATURE. Sugimoto, Shun'ichi; Kuwada, Keiji; Ohnishi, Shun'ichi; Nitta, Isamu. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 199-215(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19706.

8112 (AEC-tr-6908, pp 237-44) ELECTRON SPIN RESONANCE STUDY OF AN IRRADIATED SINGLE CRYSTAL OF BORIC ACID. Nagai, Siro; Kuwata, Keiji; Ohnishi, Shun'ichi; Nitta, Isamu. Translated from Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 217-24(1965–1966).

This paper was abstracted previously from the original language and appeared in NSA as 21: 19707.

8113 PHYSICAL PROPERTIES OF DIPHENYL, o-, m-, AND p-TERPHENYL AND THEIR MIXTURES. Friz, G.; Kuhlborsch, G.; Nehren, R.; Reiter, F. (EURATOM-CCR, Ispra, Italy). Atomkernenergie, 13: 25-8(1968).

A summary of the physical properties of diphenyl, o-, m-, and p-terphenyl for heat transfer calculations is reported. Equations are given for calculation of the physical properties of mixtures from the data of the single components. As far as known the influence of high boiler products formed by pyrolysis and radiolysis on the physical properties is given. (auth)

8114 THE RADIATION CHEMISTRY OF CYCLIC DIENES. III. THE EFFECTS OF ELECTRIC FIELDS AND ADDITIVES IN THE RADIOLYSIS OF 1,4-CYCLOHEXADIENE VAPOR. Nakagawa, Tsunehiko; Takamuku, Setsuo; Sakurai, Hiroshi (Osaka Univ.). Bull. Chem. Soc. Jap., 40: 2773-6(Dec. 1967).

In the γ radiolysis of 1,4-cyclohexadiene vapor at room temperature, the contribution of neutral and ionic intermediates to the main products was investigated by the application of electric fields and by the addition of nitrous oxide and ammonia as an electron and an ion scavenger, respectively. It was suggested that the precursors of hydrogen, acetylene, and 1,3-butadiene are exclusively the neutral excited molecules of 1,4-cyclohexadiene directly produced by the γ irradiation, while those of the C_6 products and polymer are mostly the ionic species. It was further derived that the contribution of neutralization reaction has little importance in the formation of hydrogen, acetylene, and 1,3-butadiene. (auth)

8115 STUDIES ON POLYMERS FROM CYCLIC DIENES. VI. RADIATION POLYMERIZATION OF THE THIOUREA COMPLEX OF CYCLOPENTADIENE. Aso, Chuji; Kunitake, Toyoki; Ishimoto, Yoshikazu (Kyushu Univ., Fukuoka). Bull. Chem. Soc. Jap., 40: 2894-9(Dec. 1967).

The gamma radioinduced polymerization of the thiourea complex of cyclopentadiene was investigated. The conditions for preparing the complex were an important factor in increasing the conversion, the use of 50 vol % aqueous acetone giving the best results. The polymer yield increased with dose and with temperature. The apparent activation energy of the polymerization was 2.7 kcal/mole was concluded from NMR and ir spectral data that the polycyclopentadiene thus obtained had mainly the 1,4-structure. (auth)

8116 PHOTOCHEMICAL REACTION OF TECHNETIUM(IV) CHLOROCOMPLEXES. Fujinaga, Taitiro; Koyama, Mutsuo; Kanchiku, Yoshihiko (Kyoto Univ.). Bull. Chem. Soc. Jap., 40: 2970-1(Dec. 1967).

The photochemical behavior of Tc(IV) chlorocomplexes in 1, 3, 6, and 12$\underline{N}$ HCl solutions was investigated. One series was placed in a dark box and the other was irradiated with four 10 W flourescent lamps in a thermostat at 20°C. Absorption spectra of the samples that were kept in the dark box remained unchanged regardless of their hydrochloric acid concentrations. The irradiated ones changed gradually to reach equilibria depending on the concentration of hydrochloric acid in a given sample. (J.G.B.)

8117 ENERGY SPECTRUM OF ELECTRONS IN POLYSTYRENE. Nakai, Yohta; Matsuda, Kohji; Takagaki, Torao; Kimura, Ki-ichi. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 5-9(1966-67). (In Japanese).

The slowing down spectrum of secondary electrons in polystyrene was obtained experimentally for well collimated, monoenergetic electron beams of one MeV from a Van de Graaff accelerator. The intensity of the electron was measured as a function of the energy. The peaks of the spectrum were shifted to the low-energy region with increasing thickness of polystyrene foils. Discussion on integrative quantity of the spectrum is limited, because the linearity of scintillator was poor below 100 keV. (auth)

8118 OXYGEN UPTAKE DURING IRRADIATION AND POST-IRRADIATION GRAFT COPOLYMERIZATION OF STYRENE ONTO POLYVINYL ALCOHOL. Kimura, Fujiko; Sakurada, Ichiro. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 11-18(1966-67). (In Japanese).

Flaked and powdered poly(vinyl alcohol), which was subjected to heat treatment at various temperatures, was irradiated with γ rays in air of 200 mm Hg at 25, 40, and 60°C and the amount of oxygen consumed was measured by means of mass spectroscopy. After measuring oxygen uptake, graft copolymerization of styrene onto the preirradiated poly(vinyl alcohol) was carried out in vacuo. The amount of oxygen consumed decreased linearly with rising temperature of heat treatment, and increased with rising irradiation temperature. The results suggest that oxygen uptake during irradiation decreased with increasing crystallinity. The percentage of graft was not observed to change with heat treatment. Therefore, the percentage graft was independent of the amount of oxygen consumed. (auth)

8119 PROPERTIES OF STYRENE GRAFTED CELLULOSE. Kimura, Fujiko; Okada, Toshio; Sakurada, Ichiro. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 19-30(1966-67). (In Japanese).

The water repellency of styrene-grafted cellulose prepared by two different methods of radioinduced grafting was compared. Sample E was obtained by grafting in an aqueous emulsion of the monomer and S by grafting in a styrene−methanol−water solution. Cotton and rayon cloths were employed for the experiments. In both cases sample S showed much higher water repellency than E. The degree of swelling in water for sample E was much higher than that for S. Similar samples of grafted cellulose were also prepared from cotton and rayon fibers. It was found that the grafted fibers of rayon could be drawn to twice their original length in suitable liquids such as xylene and dimethylformamide at an elevated temperature. The drawing was very effective in obtaining styrene-grafted rayon of high tenacity. Tearing strength, especially that of wet, styrene-grafted rayon cloths, was studied. The low wet tearing strength was attributed to radiation damage during preirradiation; styrene grafting had little effect on improving the wet tearing strength of rayon. (auth)

8120 RADIOLYSIS OF POLY(VINYL ALCOHOL) GASEOUS PRODUCTS FROM POLY(VINYL ALCOHOL) AND DEUTERATED POLY(VINYL ALCOHOL) WITH GAMMA IRRADIATION. Okada, Toshio. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 31-41(1966-67). (In Japanese).

Gases evolved from the gamma radiolysis of deuterated and normal poly(vinyl alcohol) were studied using a mass spectrometer over a temperature range of 12 to −196°C. The evolved gas was composed of above 99% hydrogen and a small amount of carbon dioxide, carbon monoxide, and methane. The deuterium isotope effect was very small in the irradiation at 12°C, but it increased with decreasing temperature. The irradiation at −196°C gave an isotope effect of 2.27. The isotopic composition of evolved hydrogen gas did not appreciably differ from that of the polymer. The cleavage of the hydrogen−oxygen bond in poly(vinyl alcohol) is discussed. (auth)

8121 EFFECT OF BENZALIZATION AND BENZOYLATION ON IRRADIATION DAMAGE OF POLYVINYL ALCOHOL FILMS. Kohdera, Kanako; Kimura; Fujiko; Sakurada, Ichiro. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 43-50(1966-67). (In Japanese).

Poly(vinyl alcohol) (PVA), and benzalized and benzoylated PVA films were exposed to γ rays in vacuo and in air. At the dosage of 2×10^7 R, the tensile strength of PVA film was 1.2 times as great as that of nonirradiated one. After the dosage of 6×10^7 R, the tensile strength was found to be still above its original value. Elongation decreased continuously with increasing dose. The tensile strength of benzalized PVA decreased sharply with irradiation in air and remained unchanged with irradiation in vacuo. In the case of benzoylated PVA, the tensile strength remained unchanged with the dosage up to 6×10^7 R both in vacuo and in air. Shapes of ESR spectra in derivatives of PVA were different from that of PVA. G-values for free radial formation in PVA and its derivatives at 25°C calculated from the initial slope of the radical concentration–dose curves were as follows: G(R·) in vacuo = 10.7 for PVA, 2.5 for benzalized PVA, and 0.8 for benzoylated PVA; G(R·) in air = 5.9 for PVA, 0.5 for benzalized PVA, and 0.8 for benzoylated PVA. (auth)

8122 RADIATION-INDUCED POLYMERIZATION OF SOME CYCLIC MONOMERS IN LIQUID STATE. Ueno, Katsuji; Tsukamoto, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 51-4(1966-67). (In Japanese).

The radioinduced polymerization of some pure cyclic monomers in the liquid state was studied under extremely anhydrous conditions. Only 3,3-bis(chloromethyl)-oxetane (BCMO) and trioxane (TOX) gave fairly high yields and molecular weights, but under the same conditions, other cyclic ethers such as tetrahydrofuran did not polymerize. The polymerizations of BCMO and TOX were very sensitive to drying conditions, and their polymerization mechanism may be cationic. (auth)

8123 FREE ION MECHANISM ON RADIATION-INDUCED POLYMERIZATION OF ISOBUTYL VINYL ETHER. Ueno, Katsuji; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 55-64(1966-67). (In Japanese).

The radioinduced cationic polymerization of bulk isobutyl vinyl ether was studied under anhydrous conditions. It was found that the rate of polymerization is proportional to about the square root of dose rate where relatively low doses were used. A mechanism involving bimolecular termination of free ions was therefore indicated. The lifetime of polymerization was measured directly by the pulse irradiation method. A preliminary result showed that it is 0.2 sec in the conditions of 42.5°C and 5.3×10^4 R/hr. (auth)

8124 STUDIES ON RADIATION-INDUCED IONIC POLYMERIZATION. PART 6. EFFECT OF HIGH ELECTRIC FIELD ON POLYMERIZATION OF STYRENE. Ueno, Katsuji; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 65-70(1966-67). (In Japanese).

The radioinduced cationic polymerization of bulk styrene was studied under a high electric field. It was found that the rate of polymerization at 25°C increased with application of the electric field of 6kV/cm, leveling off at a higher electric field. The results were interpreted in terms of the increase of free ions and the relative lifetime of both positive ions (growing chains) and negative ions under a high electric field. (auth)

8125 STUDIES ON RADIATION-INDUCED IONIC POLYMERIZATION OF STYRENE. PART 7. EFFECT OF ELECTRON SCAVENGERS ON POLYMERIZATION OF STYRENE. Ueno, Katsuji; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 71-8(1966-67). (In Japanese).

The role of ejected electrons on the radioinduced cationic polymerization of bulk styrene was investigated. The addition of typical electron scavengers such as nitrous oxide and dichloromethane did not affect the rate of polymerization. The relative ratio of electron trapping between styrene and scavenger was measured in the solution of 3-methylpentane. The results indicated that styrene as well as nitrous oxide and dichloromethane are good electron scavengers. The existence of the anion radical of styrene was confirmed by ESR and electronic spectroscopy measurements. (auth)

8126 STUDY ON THE RADIATION-INDUCED FREE ION YIELDS IN N-ALKANES. Takada, Kiyoshi; Takagaki, Torao; Hayashi, Kanae; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 79-88(1966-67). (In Japanese).

Radioinduced free ion yields in n-alkanes, from pentane to decane was obtained from the electrical conductivity measurement and Gzowski's mobility. In alkanes lower than octane, G-values for free ion yield decreased gradually with increasing carbon number and became almost constant, 0.03 to 0.04, in octane, nonane, and decane. It was theorized that the main reason for such differences lies on the range distribution of secondary, tertiary, etc., electrons, i.e., energy distribution of emitted electrons and energy-range relation in each medium. (auth)

8127 ESTIMATE OF FREE ION LIFE TIME BY PULSE ELECTRICAL CONDUCTIVITY METHOD. Hayashi, Kanae; Takagaki, Torao; Takada, Kiyoshi; Hayashi, Koichro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 89-95(1966-67). (In Japanese).

The estimate of free ion lifetime was carried out from the combination of pulse x irradiation (repetition time, 10 to 250 msec) and electric conductivity measurements on cyclohexane. The cell current ratios decreased at slow pulses keeping the dose rate constant. A deviation from ordinary kinetics of intermittent illumination at slowest pulse was observed and a probable explanation for it was proposed. The estimated life time agreed with that calculated from steady state conductivity within a factor of two. (auth)

8128 ESR STUDY ON THE IRRADIATED ORGANIC GLASS CONTAINING STYRENE. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 103-9(1966-67). (In Japanese).

When styrene was irradiated by ionizing radiations at 77°K, it gave a five-line ESR spectrum with a hyperfine coupling constant of 16 G. This spectrum was attributed to free radicals, $CH_3\dot{C}HC_6H_5$. Irradiated 2-methyltetrahydrofuran glass containing styrene gave, at 77°K, a signal shape composed of a broad singlet spectrum (total width of 33 G) and a seven-line spectrum, but a sharp singlet spectrum due to trapped electrons which was found from irradiated pure 2-methyltetrahydrofuran glass was not observed. The seven-line spectrum was due to free radicals formed from 2-methyltetrahydrofuran. The broad singlet spectrum was thought to be due to styrene anion radicals formed through electron capture by styrene. This spectrum was bleached by visible light. The same was found for 3-methylpentane glass containing styrene. (auth)

8129 ELECTRON SPIN RESONANCE STUDY OF IRRADIATED CYCLIC ETHERS. Tsuji, Kozo; Yoshida, Hiroshi; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 111-25(1966-67). (In Japanese).

Free radicals formed by irradiating cyclic ethers at 77°K were studied by the electron spin resonance method. From cyclic ethers containing one oxygen atom, free radicals were formed mainly by the abstraction of a hydrogen atom from the carbon atom adjacent to oxygen. In the same way, free radicals were formed from cyclic ethers containing two oxygen atoms separated from each other by two carbon atoms. From cyclic ethers containing a sequence of oxygen–carbon–oxygen in the ring, free radicals were formed mainly by the ring opening. (auth)

8130 ESR STUDY OF IRRADIATED POLYOXYMETHYLENE. Tsuji, Kozo; Okaya, Takuji; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 127-37(1966-67). (In Japanese).

Electron spin resonance spectra of irradiated polyoxymethylene were observed immediately after the irradiation and after heat treatments. ESR spectra changed with radiation dose and heat treatment after the irradiation. When radiation dose was very small, the doublet spectrum observed at room temperature was asymmetric, which was found to be caused by superposition of a singlet spectrum. This singlet spectrum could be assigned to the free radical, $-O-\dot{C}=0$. The effects of air were also examined. Peroxy radicals were produced at about –78°C in powder samples but not in pellet samples. It is thought to be due to difference of ease in diffusion of oxygen. The peroxy radical disappeared at room temperature. Other free radicals were also observed in irradiated polyoxymethylene in this investigation. One of them gives a doublet spectrum with a separation of about 86 gauss, and is tentatively assigned to $HO-\dot{C}=0$. The other is the formyl radical, which gives a doublet spectrum with a separation of 125 gauss. (auth)

8131 SPECTROSCOPIC STUDIES ON RADIATION-INDUCED POLYMERIZATION. 2. RADIATION-INDUCED POLYMERIZATION OF ISOBUTENE AT LOW TEMPERATURE GLASSY STATE. Kamiyama, Hideo; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 139-50(1966-67). (In Japanese).

The reaction mechanism of radioinduced polymerization of isobutene(2-methylpropene) was studied by measurement of its near-infrared spectra in 3-methylpentane glass at liquid nitrogen temperature. Direct evidence was given for the fact that almost the entire reaction propagates as in-source polymerization at 77°K. From the measurement on the samples of various concentrations, it was concluded that the rate of polymerization is proportional to the 1.87 power of the monomer concentration. A determination of the number-averaged molecular weight by the quantitative treatment of the absorption intensity was made for the micro quantity of the obtained sample of polyisobutene, and using its results G-value of the initiation of polymerization was estimated to be about 1 for the wide range of monomer concentration. (auth)

8132 STUDIES ON RADIATION INDUCED SOLID STATE POLYMERIZATION ON THE CHAIN PROPAGATION IN THE SOLID STATE. Nishii, Masanobu; Hayashi, Koichiro; Okamura, Seizo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 151-61(1966-67). (In Japanese).

Electron microscopic observations at low temperature indicated that crystalline polymer fibrils (200 to 500A in diameter and more than 1 μ in length) were formed in a unique crystallographic direction of the monomer crystal by the radioinduced solid state polymerization of trioxane. In the solid state polymerization of acrylamide, amorphous globular polymer particles (a diameter of 300 to 400A) were formed. The chain propagation of trioxane appeared to be controlled by the regularities of ordered molecules in the crystal lattice. In the case of acrylamide, however, the reaction was not controlled by the monomer crystal lattice. (auth)

8133 RADIOLYSIS OF METHYL N-BUTYL ETHER. Takezaki, Junichi; Hirota, Kozo. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 163-8(1966-67). (In Japanese).

Primary products of the radiolysis of liquid methyl butyl ether and their G-values were as follows: H_2 1.3; CH_4 1.5; CO 0.6; C_2H_4 0.017; C_2H_6 0.016; C_4H_8 0.013. Minor products were C_3H_8, C_4H_{10}, $CH_3OC_2H_5$, $CH_3OC_3H_7$, C_6 group, C_4H_9OH and i-C_4H_9OH (all with G values 0.003). The effects of DPPH additions were investigated. (auth)

8134 ESR STUDY OF IRRADIATED POLYETHERS. Sugimoto, Shun-ichi; Ohnishi, Shun-ichi; Nitta, Isamu. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 177-83(1966-67). (In Japanese).

Free radicals formed in polyethers irradiated at low temperature were studied by ESR. A doublet-triplet spectrum was observed in irradiated polytetramethylene oxide and polydecamethylene oxide. The doublet splitting was 30 gauss and the triplet had 18 gauss splitting. The free radical responsible for this spectrum was assigned to $-CH_2\dot{C}HOCH_2-$. In polyethylene oxide–urea complex, however, the spectrum was a triplet of 21 gauss splitting. This spectrum could also be assigned to radical similar to the above mentioned one, where the conformation of the methylene group is different from the latter. (auth)

8135 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED BORON COMPOUNDS. II. SINGLE CRYSTAL OF BORAX. Nagai, Siro; Ohnishi, Shun-ichi; Nitta, Isamu. Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 8: 185-93(1966-67). (In Japanese).

A single crystal of borax, $Na_2B_4O_7 \cdot 10H_2O$, was irradiated with electron beams at –196°C. The free radicals produced in the crystal were studied by anisotropy in the ESR spectra. The EST spectra consisted of two sets of quartet, where each of these quartet structures arises from hyperfine interaction of an unpaired electron with ^{11}B nucleus. The free radicals corresponding to these quartets were assigned to the two different oxy radicals: $B(sp^2)-\dot{O}$ and $B(sp^3)-\dot{O}$. The principal values of g factor of the former radical are 2.034, 2.011, and 2.003. On the other hand, those of the latter radical are 2.089, 2.066, and 1.967. This radical has a very short spin-lattice relaxation time. (auth)

8136 EFFECT OF OXYGEN ON THE γ-RADIATION-INDUCED POLYMERIZATION OF ETHYLENE. Mitsui, Hiroshi; Machi, Sueo; Hagiwara, Miyuki; Hosoi, Fumio; Kagiya, Tsutomu (Takasaki Radiation Chemistry Research Establishment, Japan). J. Polym. Sci., Part A-1, 5: 2731-43(Nov. 1967).

The effects of oxygen on the γ-radioinduced polymerization of ethylene were studied at a temperature of 30°C; the pressure was 400 kg/cm², the dose rate was 1.9×10^5 RAD/hr, and oxygen content was from 1 to 2000 ppM. The main product was solid polymer, and no liquid product was found. The gaseous products were hydrogen, acetylene, higher hydrocarbons, carbon dioxide, aldehydes, and acids. Several kinds of carbonyls similar to those formed in γ-ray oxidized polyethylene were observed in the polymer. The polymer yield and the degree of polymerization decreased markedly with increasing oxygen content, while the amount of carbonyls in the polymer increased. The number of moles of polymer chain and the amounts of hydrogen and acetylene were found to be almost independent of the oxygen content. The polymerization of pure ethylene was not affected by carbon dioxide and formic acid. On addition of acetaldehyde, the polymer yield and the degree of polymerization decreased markedly, while the number of moles of polymer chain increased. In the polymerization of ethylene containing oxygen, both the rate of oxygen consumption and the carbonyl content of the polymer increased, while the inhibition period decreased by the addition of acetaldehyde. It was found that the degree of polymerization after the inhibition period is almost independent of the reaction time in the presence of acetaldehyde, while it increases with time in the absence of acetaldehyde. (auth)

8137 KINETICS OF γ-RAY POLYMERIZATION OF FORMALDEHYDE IN THE PRESENCE OF CARBON DIOXIDE. Yokota, Hisao (Sumitomo Atomic Energy Industries Ltd., Takarazuka, Japan); Otsuka, Yozo; Kagiya, Tsutomu; Fukui, Kenichi. J. Polym. Sci., Part A-1, 2825-34(Nov. 1967).

A kinetic study of the γ-ray polymerization of formaldehyde in toluene solution in the presence of carbon dioxide was carried out at temperatures of +13 to –17°C. Two modes of the polymerization, spontaneous and γ-ray polymerization, occur in this system. The γ-ray polymerization, experimentally separated from the spontaneous polymerization, was investigated. The rate of γ-ray polymerization increased slightly with the square root of carbon dioxide concentration. The rate of polymerization was also found to be proportional to the dose rate and the square of monomer concentration. The molecular weight of polymer formed was independent of the reaction condition. The apparent activation energy was estimated to be 10.3 kcal/mole. The kinetics of the γ-ray polymerization in the presence of carbon dioxide are explained quantitatively by a cationic mechanism, and the role of carbon dioxide is as an action of retardation for neutralization of the cationic initiating species, which was produced by γ radiation, by means of a reverse reaction with an electron. Physical and mechanical properties of the polymer obtained by γ-ray polymerization were also investigated. (auth)

8138 DETERIORATION OF POLYMERS BY IONIZING RADIATION. IV. RADIATION-INDUCED DEGRADATION OF IIR VULCANIZATES. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture); Imamura, Kunio. Nippon Gomu Kyokaishi, 40: 633-5(Aug. 1967). (In Japanese).

IIR–Sulfur vulcanizates filled with L–$CaCO_3$ and containing various kinds of rubber chemicals, and IIR–Sulfur and oxime vulcanizates filled with HAF black were subjected to ^{60}Co γ irradiation. IIR vulcanizates were deteriorated with irradiation from 5×10^6 to 1×10^7 R and becomes viscous with irradiation of 5×10^7 R. This makes the determination of vulcanizate properties impossible. Little change was observed in elongation but an extreme decrease in tensile strength was observed with an increasing radiation dose, and hence IIR seemed to be a polymer of typical degrading type. Antirads were not effective on IIR vulcanizates. (NSA of Japan)

8139 DETERIORATION OF POLYMERS BY IONIZING RADIATION. V. ANTI-RADIATION EFFICIENCY OF THE ORGANIC RUBBER CHEMICALS IN BR AND SBR VULCANIZATES. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture); Imamura, Kunio. Nippon Gomu Kyokaishi, 40: 636-41 (Aug. 1967). (In Japanese).

BR and SBR–sulfur vulcanizates containing various kinds of rubber chemicals, all of which were filled with HAF black, were irradiated with ^{60}Co γ radiation. An extreme increase of stress at 100% elongation was observed with irradiation of 1×10^7 R, and hence BR seemed to be a polymer of typical crosslinking type. Antirad improved slightly the properties of BR and SBR vulcanizates after irradiation. However, even in the presence of antirad, BR vulcanizates were deteriorated with irradiation from 5×10^7 to 1×10^8 R and SBR vulcanizates were deteriorated from 1×10^8 to 5×10^8 R. Generally speaking, antirad in BR and SBR vulcanizates was more effective than one in NR vulcanizate. Little difference in changes of 100% stress of BR and SBR vulcanizates was observed between irradiation in air and that in N_2. Changes of physical properties of BR–oxime and peroxide vulcanizates after irradiation indicated a similar tendency to those of the corresponding NR vulcanizates. (NSA of Japan)

8140 THE MOST EFFECTIVE PRODUCTION OF POLYMER GEL BY RADIATION. Takahashi, Tsuneto (Chuo Univ., Japan). Chuo Daigaku Rikogakubu Kiyo, 8: 1-10(Dec. 1965). (In Japanese).

The polymer substance to be studied is divided into two parts. Part I is exposed to radiation until a certain amount of gel is produced. Then the gel is separated from the soluble fraction and mixed with part II. The mixture is exposed to radiation until the gel grows to the required amount. The first irradiation dose and the ratio of division are so controlled that the total radiation dose will be a minimum. Part II may also be exposed to radiation before it is mixed with the gel. Theoretical calculation showed that the division of polymer substance prior to irradiation is not effective for the purpose of minimizing the necessary radiation dose, and that gel production is most efficient when the absorption dose per unit mass of polymer takes a certain amount, which depends on the G value of crosslink and the initial average molecular weight. (NSA of Japan)

8141 GAMMA-RADIOLYSIS OF L-GLUTAMIC ACID. I. RADIOCHEMICAL CHANGES FROM CRYSTALLINE L-GLUTAMIC ACID TO OTHER AMINO ACIDS. Sameshima, Muneo (Kagoshima Univ., Japan). Kagoshima Daigaku Suisangakubu Kiyo, 15: 39-44(Dec. 1966). (In Japanese).

Crystalline L-glutamic acid was subjected to γ rays in vacuo, and radiochemical changes from L-glutamic acid to other amino acids caused by decarboxylation were studied. Within the dose range from 10^7 to 10^8 RAD, L-glutamic acid was partially changed to α-amino-n-butyric acid. The yield of α-amino-n-butyric acid was linear with respect to dose, and G-value of decarboxylation of L-glutamic acid was almost equal to the G-value of α-amino-n-butyric acid formation. At a high dose, over 10^8 RAD, γ-aminobutyric acid was formed as secondary product from α-amino-n-butyric acid. (NSA of Japan)

8142 GAMMA-IRRADIATION OF MALEIC ANHYDRIDE IN BENZENE. Raciszewski, Zbigniew (Union Carbide Corp., South Charleston, W. Va.). J. Chem. Soc., B, No. 12, 1253-8 (1967).

Gamma-irradiation of a benzene solution of maleic anhydride produced a polyanhydride of low molecular weight, a small quantity of a maleic anhydride–benzene 2:1 adduct (II) (G ~ 0.06), carbon dioxide (G = 0.29), carbon monoxide (G = 0.26), acetylene (G = 0.08), and traces of ethylene and methane. Addition of a catalytic amount of benzoyl peroxide increased the yield of the polyanhydride by about 50% but its composition and the yield of (II) were virtually unchanged. The presence of cyclohexane increased the yield of the polyanhydride and decreased that of (II). Analysis of the polymer obtained in the absence of additives suggested incorporation of 3 to 4 benzenes per 6 maleic units; 2 to 3 benzenes had lost their aromaticity, but the terminal phenyl retained it. The following were calculated: G(maleic anhydride → polymer) ~2.6 to 2.2; G(benzene → polymer) ~1.2 to 1.6. The latter consisted of two terms: G(benzene → terminal phenyl) ~0.4; G(benzene → aliphatic C_6H_6) ~0.8 to 1.2. These two terms were compared with the literature data on the yields of radicals and of benzene triplets produced in liquid benzene by low LET radiation. It was concluded that (II) was formed by energy transfer from solvent to maleic anhydride, either free or complexed, and the subsequent reactions of the excited maleic anhydride with benzene. Formation of the polymer occurred by way of a short radical chain. The initation step involved scavenging of radicals, mainly phenyl, by maleic anhydride, and the propagation consisted of copolymerisation of maleic anhydride with either triplet benzene or tautomers of excited benzene such as benzvalene. (auth) (UK)

8143 RADIOLYSIS OF GASEOUS ISOBUTYLENE BY ^{60}Co γ RAYS. I. DECOMPOSITION PRODUCTS. Collin, G. J.; Herman, J. A. (Univ. Laval, Quebec, Can.). Can. J. Chem., 45: 3097-106(Dec. 1967).

The radiolysis of gaseous isobutylene yields the following products: iso-C_4H_{10}, H_2, propyne, allene, C_3H_6, C_2H_2, C_2H_4, iso-C_5H_{12}, C_3H_8, C_2H_6, neo-C_5H_{12}, and a polymer. The radiochemical yields decrease with pressure, except for the yield of the polymer. Addition of NO decreased only the yields of iso-C_4H_{10}, CH_4, C_3H_8, and C_2H_6, showing that at least partly these products are formed in radical reactions. A mechanism is proposed accounting for the formation of radiolysis products. (auth) (Canada)

8144 DETERMINATION OF FREE RADICALS IN GAMMA IRRADIATED PROTEINS. Riesz, P.; White, F. H. (National Cancer Inst., Bethesda, Md.). Nature (London), 216: 1208-10 (Dec. 23, 1967).

Studies are discussed on the use of tritiated H_2S as an interceptor of free radicals in the determination of the distribution of such radicals located on the C-atoms of irradiated proteins. The method involves exposing gamma-irradiated lyophilised proteins to the gas in order to form C–T bonds in the protein. Tritium distribution among the amino acids can be determined by subsequent hydrolysis, amino acid analysis, and tritium counting. The possibility cannot, however, be ruled out that SH radicals generated in the labeling reaction abstract hydrogen from carbon to produce a class of carbon radicals not initially formed by gamma radiolysis. This could lead to erroneous results for tritium distribution. Chain reactions for tritium incorporation might also occur. In order to examine the possible contribution of hydrogen abstraction to labeling with tritiated H_2S, tritiated HI was used as the radical interceptor; abstraction of hydrogen from carbon by iodine atoms cannot occur because of the low bond dissociation energy of HI. The reaction of free radicals with HI can be followed by observing the ESR spectrum as a function of time. Results are shown for a study in which ribonculease, gamma-irradiated to 4.2MR at room temperature, was exposed to HI at 150 torr. After 12 min a marked decrease of the doublet peak occurred due to carbon radicals. After 4 hr all of the carbon radicals had reacted, leaving only the sulphur signal, the latter being caused by sulphur radicals, formed during radiolysis, which did not react with HI. It was important to distinguish between T-labeling induced by β-decay of the tritiated radical interceptor and that introduced as a consequence of radiolytic radical formation. Experiments were devised for determining the extent of β-labeling. The observation that the amount of incorporated tritium was of the same order for both tritiated H_2S and HI was consistent with the absence of chain reaction due to SH radicals. The gamma distribution of tritium among the amino acids of ribonuclease and chymotrypsinogen is shown when tritiated H_2S and HI were used. There were many similarities between the tritium distributions for these two radical interceptors. It appeared that hydrogen abstraction by SH radicals was not a significant process. Tritium was widely distributed among amino acid residues; for a given protein the specific activities varied from very high- to very low; the specific activity of glycine was very low, indicating that glycine does not play a special part as a free radical site in these proteins. Some distortion of distributions can, however, occur when tritiated scavengers are employed. (UK)

8145 GRAFTING OF RADIATION-PEROXIDIZED LIGNIN. Koshijima, Tetsuo; Muraki, Einosuke (Govt. Ind. Res. Inst., Osaka). Zairjo, 16: 834-8(Oct. 1967). (In Japanese).

Lignin is subject to easy radiation-peroxidation. In the case of pine hydrochloric acid lignin, irradiation with 1.92 MRAD of γ radiation in air gave rise to 3×10^{19} peroxides per gram of lignin. When the peroxidized lignin was allowed to stand in air, the peroxide contents diminished in 25 days to 40%, which was, thereafter, invariable for 250 days. When styrene or methyl methacrylate was used as monomer in the grafting there was reaction of 36 parts of styrene or of 39 parts of methyl methacrylate to 100 parts of lignin, but this was not the case with ligninsulfonic acid. Up to 1.92 MRAD, the peroxixe concentration in lignin increased proportionally with the radiation period, but the grafting ratio indicated maximum value at the point of a peroxide content of 1.89×10^{19} per gram of lignin. When polystyrene branches propagated up to $\overline{P}_n$ of 100, the corresponding grafting ratio reached 35 in the radiation-peroxidation method and 200 in the case of direct irradiation. In the case of radiation-peroxidation method, the number of active centers for grafting is one-sixth the number that appeared in direct radiation grafting. From the structure of lignin and the experimental results obtained, it was concluded that the peroxides produced in the lignin molecules by pre-irradiation were mostly hydroperoxide arising from C-H scission at tertiary carbon, and less in diperoxide. (NSA of Japan)

8146 EFFECT OF GAMMA RADIATION ON THE ADSORPTIVE CAPACITY OF SILICA GEL KSM-6. Ermatov, S. E. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 48-52(July-Aug. 1967). (In Russian).

The effect of γ radiation on the adsorptive properties of silica gels KSK and KSM-6 for hydrogen, oxygen, and dry air was studied. A significant increase in the adsorptive capacity occurred. The amount of additional adsorption of the irradiated silica gels KSK and KSM-6 differed for different gases and fluctuated considerably per gram of adsorbent. The amount of additional adsorption of the irradiated adsorbent for a given dose increased with increasing irradiation rate. The rate of additional adsorption had a maximum value in the first moments of contact of the irradiated adsorbent with the gas. At low temperatures the rate of additional adsorption was significantly increased. The isotherm of additional adsorption of irradiated silica gels in the pressure range studied was linear. (tr-auth)

8147 SYNTHESIS OF ION-EXCHANGE MEMBRANES BY MEANS OF A RADIOCHEMICAL METHOD. NOTE II. ANION-SELECTIVE MEMBRANES AND THEIR ELECTROCHEMICAL PROPERTIES. Munari, Stelio; Vigo, Fernando; Rossi, Corrado; Tealdo, Giancarlo (Univ., Genoa. Centro Nazionale di Chimica delle Macromolecole, Genoa). Ric. Sci., 37: 641-7(July-Aug. 1967).

Anion exchange membranes were built up from styrene radiochemically grafted on to PTFE. An attempt was made to characterize some of their mechanical and electrochemical properties. (auth)

8148 ION LIFETIMES IN IRRADIATED GASEOUS HCl. Armstrong, D. A.; Back, R. A. (National Research Council of

Canada, Ottawa). Can. J. Chem., 45: 3079-82(Dec. 1967). (NRC-9708).

An intermittent-field method was used to measure ion lifetimes in gaseous HCl during irradiation by gamma rays under conditions of pressure, dose rate, and vessel geometry similar to those employed in radiolysis studies. At 23°C, with HCl pressures from 119 to 660 torr and dose rates from 5.5 to 86×10^{10} eV cc^{-1} s^{-1}, the ion half-life ranged from 6 to 30 ms. The dependence on dose rate and pressure strongly indicated that ion neutralization occurred almost entirely in the gas phase. Values of α, the gas-phase combination coefficient, were calculated; at pressures above 246 torr the value was constant and equal to $3.1 \pm 0.3 \times 10^{-6}$ cc $ions^{-1}$ s^{-1}. The addition of SF_6 had little effect on α, while reducing the temperature to -79°C increased α to 5.1×10^{-6}. (auth) (Canada)

8149 RAPID DISTILLATION SEPARATION OF MICROGRAM QUANTITIES OF FLUORIDE. Kubota, Hisashi (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Microchem. J., 12: 525-33(Dec. 1967). (ORNL-P-3060).

A modification of the Willard-Winter separation of fluoride was developed, which gives good recovery of microgram quantities of fluoride from solutions containing cations that form very stable fluoride complexes and large quantities of volatile mineral acids. The separated fluoride was determined spectrophotometrically with the alizarin–complexone reagent. The distillation procedure was devised to separate fluoride simply and rapidly and it took into consideration the limitations of hot-cell operations. The effects of various ions were investigated and no interference was observed except for sulfate. The halides and nitrate distilled but did not interfere while borate and phosphate did not distill. The transuranium elements, Al, Zr, and Fe did not distill. No interference was observed from elements that form volatile oxyfluorides like Mo and Nb. The stability of the alizarin-complexone chromophore to the effects of ^{60}Co radiation was determined. It was found that there was nearly 1% loss in absorbancy/100 RAD absorbed dose and the rate of bleaching was linear at least to 50,000 RAD. The order of radiation stability seemed adequate in view of the radiation intensities that are now being encountered in the hot cells. (D.H.M.)

8150 MODEL FOR THE MEASUREMENT OF DOSE RATE OF IONIZING RADIATION WITH THE HELP OF ELECTROLYTIC FLOW-THROUGH CELLS. Wolschendorf, K. (Univ., Kiel). Atomkernenergie, 12: 433-46(1967). (In German).

Radiation effects on the conductivity of organic halogen compounds were studied for the purpose of developing a model to measure dose-rate directly by means of radiochemical methods. Corresponding to the differential quotient dE/dt of the conductivity effect E there is a characteristic function F(J) by means of which the dose-rate of the applied radiation can be defined. This characteristic function was determined. The system worked at dose-rates up to 30,000 R/min. A theoretical relation was derived for the characteristic function F(J). By comparison with the experimental data it was found that F(J) does not only depend on the chemical system but is also a function of the geometrical arrangement. The influence of irradiation conditions as photon energy, temperature, and concentration upon the characteristic function was studied. The change of F(J) with the applied tube voltage was determined and discussed. Quantitative measurements of the effect of temperature and concentration agreed well with calculated data. A model for direct measurement of the quantity dE/dt is explained. The differentiation of the effect E was carried out by making the solution stream through the conductivity cell with a constant velocity v. A theoretical relation to describe the properties of this arrangement was derived and found to correspond to the experimental data. Transient phenomena of the system were determined by oscilloscopical measurement and were explained by the theory. The rise-time was found to be chiefly a function of cell dimension and streaming velocity; it did not depend on the applied chemical system. (auth)

8151 ION LIFETIMES IN GASEOUS RADIOLYSIS SYSTEMS. Wood, C. J.; Back, R. A.; Dawes, D. H. (National Research Council of Canada, Ottawa). Can. J. Chem., 45: 3071-8(Dec. 1967). (NRC-9707).

A technique is described for measuring ion lifetimes in irradiated gases. Gases were irradiated continuously, and lifetimes were determined by measuring average ion currents, obtained with an intermittent square-wave applied field, as a function of square-wave period. The dose rates, pressures, and vessel geometry were similar to those commonly used in radiolysis experiments, so that the information obtained can be applied directly to an understanding of radiolysis mechanisms. The theory of the method and analysis of ion-loss processes are discussed in some detail. Measurements in oxygen at pressures from 30 to 300 torr and dose rates from 1.5 to 56×10^{10} eV cc^{-1} s^{-1} gave mean ion lifetimes ranging from 0.014 to 0.082 s. The dependence of lifetime on dose rate and pressure indicated that ion loss under these conditions was almost entirely by gas-phase combination. Values of α, the gas-phase combination coefficient, are compared with those measured by other methods. (auth) (Canada)

8152 INDUSTRIAL POLYMER IRRADIATION. Charlesby, A. (Royal Military College of Science, Shrivenham, Eng.). J. Brit. Nucl. Energy Soc., 6: 301-4(Oct. 1967).

Radiation is primarily of value in chain reactions, particularly in the solid state, and particularly in polymeric materials, where the small amount of chemical change can produce large physical modifications of practical value. The cost of irradiation has greatly diminished, but a large-scale installation is needed for practical and economic considerations. A number of applications have been in widespread use for some time. Further applications require closer collaboration between the industrialist, who knows where problems lie, and the radiation chemist, who is best able to judge which problems can, and which cannot, be solved by his technique. (auth) (UK)

8153 REVIEW OF INDUSTRIAL RADIATION CHEMISTRY IN THE UNITED STATES. Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). J. Brit. Nucl. Energy Soc., 6: 310-19(Oct. 1967). (BNL-11294)..

As an industrial process, radiation chemistry is in its infancy. Some commercial success was attained in polymer modification applications, and several commercial processes were suggested, but it is too early to evaluate their impact. A significant effort in process development, particularly in the synthesis of polyethylene and polyethylene copolymers, and in the design of radiation chemistry reaction vessels, is under way in US National Laboratories. An appreciable long range effort is also aimed at developing nuclear reactors as an energy source for endothermic reactions. (auth) (UK)

8154 CHANGES OF RADIOLUMINESCENCE YIELD IN THE POLYMERIZATION PROCESS OF STYRENE SCINTILLATORS AT VARIOUS POLYMERIZATION TEMPERATURES. Polacki, Z.; Grodel, M. (Inst. of Tech. Danzig, Poland). Acta Phys. Pol., 32: 521-3(1967). (In Polish).

In order to elucidate the influence of styrene monomer occurring in polystyrene scintillator blocks on the scintillation yield, the dependence of the relative radioluminescence yield on polymerization time was studied for different solutions. The results of further observations of this dependence at various polymerization temperatures are given. (auth)

8155 INTERNATIONAL CONFERENCE ON PHOTOCHEMISTRY, SEPTEMBER 6–9, 1967, MUNICH. PART I AND II. Munich, Max-Planck-Institut fuer Kohlenforschung, 1967. 755p. (CONF-670954-(Pt. I and II)). DTIE.

Sixty-eight papers presented at the conference are included. Topics covered include: photochemistry in the gas phase; free radical reactions; intermediates in photochemical reactions; reactions of optically excited species; and fluorescence and phosphorescence. Separate abstracts were prepared for three papers. (D.H.M.)

For abstracts of individual papers see: 8060, 8156, and 8184.

8156 ELECTRON SPIN RESONANCE STUDIES OF SOME NITROGEN RADICALS IN PHOTOLYTIC AND RADIOLYTIC SYSTEMS. Wan, J. K. S. (Queen's Univ., Kingston, Ont.). pp 368-81 of International Conference on Photochemistry, Sept. 6–9, Munich. Part I and II. Munich, Max-Planck-Institut fuer Kohlenforschung, 1967.

See CONF-670954-(Pt. I and II).

Some ESR studies of a few stable nitrogen radicals prepared by the reaction of photolytically produced hydrocarbon radical with azobenzene molecules, or by γ-irradiation of some solid ammonium compounds, are presented. In the cumene-azobenzene systems, uv-irradiation led to formation of nitrogen radicals with structure similar to that of 2, 2-diphenyl-1-picrylhydrazyl. Various substitutions on the azobenzene molecule changed the rates of radical formation and the ESR spectra. In the γ-irradiated system of polycrystalline NH_4PF_6, NH_3^+ and $N_2H_4^+$ radicals were produced and stabilized in the crystal lattice. With Me_4NPF_6, the corresponding Me_3N^+ and $N_2Me_4^+$ were observed. Existing evidence of an ammonium radical NH_4 is reviewed. (auth)

8157 METHOD FOR POLYMERIZING DERIVATIVES OF ITACONIC ACID BY IONIZING RADIATION. Wakasa, Ryoichi (to Asahi Chem. Ind. Co., Ltd.). Japanese Patent 1966-10715. June 15, 1966. Filed July 11, 1962.

A method is proposed for polymerizing itaconic acid derivatives, itaconic diesters or itaconic anhydride, in solid or liquid phase with ionizing radiation to give a high yield and higher-molecular-weight products than polymers obtained by the conventional method. The polymers can also be converted into useful water-soluble resins by hydrolysis, or ammonia or hydrazine treatment. To produce copolymers of itaconic acid derivatives and vinyl monomers, a mixture of itaconic diester or itaconic anhydride and the vinyl monomer is irradiated with ionizing radiation. (NSA of Japan)

8158 METHOD FOR PRODUCING RADIOACTIVE IODINE BY A TEMPERATURE GRADIENT CHROMATOGRAPH. Yajima, Seishi (to Japan Atomic Energy Research Inst.). Japanese Patent 1966-15399. Aug. 30, 1966. Filed Sept. 11, 1962.

A method is proposed for the production of ^{131}I, ^{132}I, and ^{133}I. The powder of a solid material, which does not react with O_2 or I_2, is packed into a column, which has a temperature gradient from room temperature to a high temperature. Neutron-irradiated U or Te, or fission products are placed on top of the packed powder. Then, air or oxygen is passed through the column, and iodine deposited in the vicinity of 80°C is collected. (NSA of Japan)

8159 METHOD FOR PRODUCING ANTI-SHOCK MOLD GOODS OF A VINYL ALCOHOL AND OLEFIN COPOLYMER RESIN. Yoshitake, Toshihiko (to Kurashiki Rayon Co., Ltd.). Japanese Patent 1966-21994. Dec. 22, 1966. Filed Mar. 16, 1964.

A method is proposed to improve the usually inferior anti-shock property of vinyl alcohol and olefin copolymer mold goods. Powders of vinyl alcohol and olefin copolymer resin were irradiated with ionizing radiation. The irradiated resin was contact-treated, with either a diene compound, and a monomer containing a diene compound, or its solution, keeping the resin in the powder phase, which gives a copolymer resin containing a graft copolymer. The resulting product is molded into desired goods. (NSA of Japan)

8160 METHOD FOR REFINING SMOKE FLAVORS. Sunada, Takeshi. Japanese Patent 1966-19583. Nov. 14, 1966. Filed Oct. 11, 1963.

An improved method using ionizing radiation is proposed for refining a smoke flavor, which is a purified tar resulting from the dry distillation of wood used to give a flavor of "smoke" to foods. By irradiating purified wood tar with ionizing radiation, such as γ rays from radioisotopes or accelerated electrons, to a dose of 1×10^6 to 5×10^7 RAD, the objectionable phenol smell is removed while the delicate smoke flavor is retained. (TSS)

8161 METHOD FOR GRAFT POLYMERIZING TO POLYMERS OF THE POLYESTER SYSTEM. Tomioka, Kenji (to Toyo Rayon Co., Ltd.). Japanese Patent 1966-19836. Nov. 17, 1966. Filed Oct. 28, 1963.

An improved method, using ionizing radiation, for graft polymerizing an unsaturated organic acid to a polymer of the polyester system consists of irradiating a polymer of the polyester system with ionizing radiation and then bringing the polymer into contact with an unsaturated organic acid. An inhibitor to inhibit the polymerization of unsaturated organic acid and a stronger acid than the organic acid are added to the reacting system. (NSA of Japan)

8162 METHOD FOR PRODUCING A POLYMER OF QUATERNARY AMMONIUM COMPOUND. Kitanishi, Yasuhisa (to Teijin Ltd.). Japanese Patent 1966-20956. Dec. 7, 1966. Filed Feb. 5, 1964.

A method is proposed to produce a polymer that is soluble in water, is adsorbed as a thin film on the surface of another material, and can be firmly attached on the surface by heating to make it resistant to washing or abrasion. The polymer is widely used for antistatic and other purposes. (TSS)

8163 METHOD FOR PRODUCING FLUOROCHLOROETHERS BY IONIZING RADIATION, AND FOR PRODUCING FLUOROCHLOROALLYLETHERS DERIVED THEREFROM. Inukai, Kagami (to Agency of Ind. Sci. and Tech.). Japanese Patent 1966-13254. July 26, 1966. Filed Mar. 25, 1964.

Simple and economic methods are proposed for producing fluorochloroethers and fluorochloroallylethers, valuable intermediates for polymeric substances, agricultural chemicals, medicines, etc., by γ-irradiation of a mixture of fluorotrichloroethylene or difluorodichloroethylene, and tetrahydrofuran, dioxane, or diethyl ether. In the production of fluorochloroallylethers, the fluorochloroether obtained is dehalogenated by means of a metal powder in a polar solvent miscible freely with water. (NSA of Japan)

8164 IMPROVEMENTS IN AND RELATING TO RADIOACTIVE PARTICLES AND THEIR PRODUCTION. (to Minnesota Mining and Mfg. Co.). British Patent 1,094,549. Dec. 13, 1967. Priority date Aug. 24, 1964, United States.

A particulate source of radiation consists of heat-treated, water-insoluble, dehydrated carbonaceous particles of an organic ion-exchange resin having a radioisotope dispersed and structurally bonded within the particles. The source is produced by contacting a solution containing the radioactive ions with an organic ion-exchange resin capable of exchanging the radioactive ions in solution for a period of time sufficient to bring about significant ion exchange. The resin is removed from solution and heat treated at a dehydrating temperature up to about 450°C to shrink and dehydrate the resin and to convert the resin to a carbonaceous, non-ion-exchanging form from which the radioactive ions are substantially nonleachable. (B.L.M.)

8165 PARAMAGNETIC DEFECT CENTERS IN SINGLE CRYSTAL CALCITE. Serway, Raymond A. Chicago, Illinois Inst. of Tech., 1967. 135p.

Thesis.

Single crystals of calcite, $CaCO_3$, exposed to x rays, γ rays, and neutrons were studied by electron spin resonance (ESR) absorption spectroscopy. A number of paramagnetic defect centers are produced by these radiations; some of these are stable only at temperatures below 100°K while others are stable up to room temperature. An axially symmetric ESR absorption spectrum consisting of four principal hyperfine structure components was observed in γ-irradiated calcite. From the hyperfine structure multiplicity and the value obtained for the ratio of nuclear to electron magnetic moment, it was concluded that the paramagnetic center is associated with the 100% naturally abundant ^{75}As nucleus. The spectrum is identified as being due to the AsO_3^{2-} molecule-ion, which occurs as a substitution for the CO_3^{2-} molecule-ion in calcite. Two paramagnetic defect centers associated with phosphorous impurities and corresponding to $S = \frac{1}{2}$ and $I = \frac{1}{2}$ were also observed in irradiated single-crystal calcite. One center, produced by γ-irradiation, has an ESR absorption spectrum, which consists of six doublets at 77°K and below, each exhibiting orthorhombic symmetry. As the temperature is raised, the lines of this spectrum broaden and at about 150°K the spectrum collapses into one doublet pattern, which exhibits symmetry about the calcite [111] direction suggesting that the coordinates of the defect center undergo some form of motion whose mean z-axis is parallel to the calcite [111] direction. This behavior is attributed to thermally induced reorientations of the defect between the magnetically inequivalent sites. The activation energy for this reorientation is estimated to be 0.10 eV from low-temperature line-broadening data. An electron nucleus double resonance absorption spectrum observed at 4.2°K demonstrated that the doublet is associated with ^{31}P. It was concluded that the center giving rise to this ESR spectrum is the PO_4^{2-} molecule-ion. The second phosphorous defect center was produced by neutron irradiation and has an ESR absorption spectrum consisting of an axially symmetric doublet pattern. This center is identified with the PO_3^{2-} molecule-ion, which is believed to occur as a substitution for the carbonate ion. The ESR absorption spectra of two primary paramagnetic defect centers, the CO_3^- and CO_3^{3-} molecule-ions, were studied in x- and γ-irradiated calcite. Both species have symmetry about the calcite [111] direction and have magnetic parameters that are similar to those reported for the isoelectronic NO_3 and NO_3^{2-} species. Optical absorption measurements reveal two bands, one at 6500 and another at 4850 Å. The longer wavelength band exhibits anisotropy and have temperature dependent decay characteristics similar to those of the CO_3^- molecule-ion ESR spectrum. An activation energy of 0.12 eV was obtained for this center. Another ESR absorption spectrum consisting of six lines was attributed to a distorted CO_3^- species having orthorhombic symmetry. This distortion is believed to be due to some form of charge compensating mechanism. (Disser. Abstr.)

Separation Processes

Refer also to abstracts 8024 and 8763.

8166 (BNL-50085) EXTRACTION OF CESIUM POLYIODIDES FROM SYNTHETIC WASTE SOLUTIONS INTO NITROBENZENE. Slater, Louis M. (Brookhaven National Lab., Upton, N. Y.). Nov. 1967. 16p. Dep. CFSTI.

Cesium polyiodides were extracted from various synthetic reactor fuel element reprocessing plant waste solutions into $0.2\underline{M}$ I_2 in nitrobenzene. Extraction coefficients ranged approximately from ten to twenty. Separation factors from fission products and process chemicals were great. Using a sixteen-stage mini mixer-settler, cesium ($\approx 5 \times 10^{-4}\underline{M}$) was separated from a synthetic waste solution by a factor of one million. (auth)

8167 (CEA-R-3224) CONTROLE ELECTRONIQUE D'UNE BATTERIE D'EXTRACTION DE PLUTONIUM. (Electronic Control of a Plutonium Extraction Battery). Degryse, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 104p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

Various aspects of the measurement of plutonium retention in an extraction battery using neutron detectors were studied. The static and dynamic tests carried out on the battery are described and an elementary theory concerning its method of operation is postulated. Two essential modes are defined: with and without leakage of plutonium into the refined liquid. The optimum operational conditions were determined. The control chain is described and the estimated performance given. The equilibrium and the transient states observed after regulation are compared with those calculated theoretically. Operational results obtained before and after regulation are also compared. (auth)

8168 (CEA-R-3230) ANALYSE ET SEPARATION DES ISOTOPES DU BORE. (Analysis and Separation of Boron Isotopes). Perie, Michele (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 70p. (In French). Dep.

Thesis. Submitted to Paris Univ., Orsay, France.

The nuclear applications of ^{10}B justify the study of a method of measuring its isotopic abundance as well as of very small traces of boron in different materials. A systematic study of thermoionic emission of $BO_2Na_2^+$ was carried out. In the presence of a slight excess of alkalis, the thermoionic emission was considerably reduced. On the other hand, the addition of a mixture of sodium hydroxide-glycerol (or mannitol) to borax permits an intense and stable beam to be obtained. These results permitted an operative method to be established for analysis of traces of boron by isotopic dilution. Procedures for separation of isotopes of boron were studied. A considerable isotopic effect was exhibited in the chemical exchange reaction between methyl borate and borate salt in solution. In the case of exchange between methyl borate and sodium borate, the elementary separation factor α is: $\alpha = (^{11}B/^{10}B)_{vap}/(^{11}B/^{10}B)_{liq} = 1.03_3$. The high value of this elementary effect was multiplied in a distillation column in which the problem of regeneration of the reactives was resolved. An alternative procedure replacing the alkali borate by a borate of volatile base, for example diethylamine, was also studied (α = 1.02_5 in a hydromethanolic medium with 2.2% water). (auth)

8169 (EURAEC-1934) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 29, April 1–June 30, 1967. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contracts 006-65-7RCIB(RD); 016-65-1RAP-B. 86p. (EUR-3758). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Research was continued on the use of ClF_3 as a fluorinating agent for direct attack on compact ceramic fuels, with the aim of cutting out the need for prior atomization. Efforts were made to determine the influence of the plutonium concentration on the rate of uranium volatilization from compact material. The tests were carried out on uranium dioxides and on mixed uranium and plutonium dioxides. One investigation was carried out on pellets in a licked bed, and another on high-density microspheres using a thermobalance. It was concluded that chlorine trifluoride at 300°C can be used for direct attack on these high-density compact mixed dioxides. At plutonium contents of around 20%, the rate of uranium volatilization was sharply reduced but the reaction residue was still broken up and atomized. The uranium was entirely volatilized before any plutonium volatilization became apparent. Two experimental direct attacks on compact uranium and plutonium mixed dioxides (of high density and containing 15% plutonium dioxide) with monofluoride showed that the reaction occurred slowly at 450 and 500°C. In addition, tests were performed with mixtures of chlorine trifluoride and monofluoride to attentuate the volatilization of plutonium with chlorine trifluoride above 300°C. With a high chlorine monofluoride concentration, the rate of plutonium volatilization was substantially cut. The construction of an assembly processing unit continued. The civil engineering works are complete, and the apparatus is being erected. Tests were effected involving mechanical and chemical decanning. A reagent consisting of 40% hydrogen fluoride and 60% oxygen, used without any diluent, seems to be most suitable, for chemical decanning of stainless steel-clad elements. As soon as the temperature rose above 650°C, the reaction rate decreased, so that the temperature was automatically adjusted. The solidifications and agglomerates, which occurred in the past, were the result of a reaction between the alumina in the fluidized bed and the hydrogen fluoride. Prefluorinating the alumina ruled out any solidification, and even prevented any agglomerate formation. Variance analysis was applied to the reaction between uranium dioxide (containing fissium) and chlorine trifluoride. The effects of temperature, presence of fissium, presence of alumina, and the bed depth/diameter ratio were determined. In addition, preliminary oxidation tests in a two-section column were carried out. Pellets of uranium dioxide, canned with stainless steel and coming from rods cut into 10-mm-long pieces, were subjected to the effects of chlorine trifluoride. Moreover, using a large-diameter (10 cm) reaction column, an attempt was made to determine the extent of the reaction zone when uranium dioxide pellets were attacked with chlorine trifluoride. This column was also used in heat-exchange research designed to define adequate cooling system, and for determining the axial and radial temperature profile in a uranium dioxide load placed in the column. Preparation of the hot technology laboratories continued. In the plutonium laboratory, preliminary tests were carried out involving reactions (with hydrogen fluoride and/or chlorine fluorides) on uranium and plutonium oxides. (auth)

8170 (INR-P-840/VIII/C) INFLUENCE OF TEMPERATURE ON THE TRACER-LEVEL SEPARATIONS BY ION EXCHANGE CHROMATOGRAPHY. Dybczynski, R. (Institute of Nuclear Research, Warsaw (Poland)). [1967]. 24p. Dep. CFSTI.

The effect of temperature on separation of trace amounts of substances by ion-exchange chromatography is discussed. The overall influence of temperature on final resolution of chromatographic peaks consists of corresponding contributions due to changes of separation factor and of plate height. Both separation factor and plate height can either decrease or increase or remain constant with the rise in temperature depending on the separated species and ion-exchange system employed. A general classification of possible changes in resolution resulting from the variation of separation factor and of plate height is given, and numerous examples are presented. (auth)

8171 (NP-17174) FINAL INACTIVE TESTS OF THE EUROCHEMIC PLANT. Marcus, F. (ed.) (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Apr. 1967. 47p. (ETR-205). Dep.

The run-in of the main Eurochemic plant with inactive uranium is described. Experience gained is summarized and the performance of each unit during an overall "Reference Run" test is presented. (auth)

8172 (RLO-1053-4) SEPARATION EFFICIENCY OF SOLVENT EXTRACTION SYSTEMS. Progress Report No. 11, October 1, 1966–November 30, 1967. Babb, Albert L. (Washington Univ., Seattle. Dept. of Nuclear Engineering). Dec. 1, 1967. Contract AT(45-1)-1053. 511p. Dep. CFSTI.

The factorial experiment to determine the effects of interfacial tension was expanded to include a series of photographs of the drop regime at different operating conditions. A mathematical model for the transient holdup was developed and tested against smoothed experimental data. The model provided substantial agreement and comparative plots showing this agreement are presented. Examination of the major available data on steady-state holdup without mass transfer was continued. Results from the second stage of regression analysis are presented. Preliminary indications are that the three-parameter fit used to describe the holdup is cruder than desirable. A general tabulation of the data is presented and the computer programs are presented as a description of the technique used. (M.C.G.)

8173 (SZS-13/67) BEHANDLUNG RADIOAKTIV KONTAMINIERTER WAESSER MIT SYNTHETISCHEN IONENAUSTAUSCHERN (LITERATURUEBERSICHT). (Treatment of Radioactively Contaminated Water with Synthetic Ion Exchangers (Literature Survey). Bosholm, J. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug. 1967. 54p. (In German). Dep.

Data given in the literature on the use of synthetic ion-exchange resins for the treatment of radioactively contaminated waters are surveyed and summarized. Pretreatment methods and mobile water purification units are also considered. (104 references) (auth)

8174 (AEC-tr-6922) METHOD FOR THE SEPARATION OF TRIVALENT LANTHANIDES FROM EACH OTHER OR FROM YTTRIUM BY PARTITION. Fischer, Werner. Translation of German Patent 1,052,968, Supplement to the Patent 957,478. 9p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

It was found that multivalent ether and cyclic ether are able to dissolve large amounts of the thiocyanates of the lanthanides and yttrium and are suitable for their separation by multiplicative partition. Under the conditions described alcohols were suitable for the separation of yttrium earths. It was also found that the separation can be directed in various directions by certain additions. (M.C.G.)

8175 (ANL-Trans-544) SEMIANNUAL REPORT OF THE CHEMISTRY DEPARTMENT, JUNE–NOVEMBER 1966. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National

Lab., Ill., from report CEA-N-816. 38p. Dep. CFSTI. JCL $4.60 fs, $1.43 mf.

Nonaqueous separation processes in fuel reprocessing are discussed. Treatment of U–Zr and U–Al alloys, separation of U from Pu starting with a mixture of their hexafluorides, removal of Mg cladding from fuels by fusion, and high-temperature electrolysis are reported. (M.C.G.)

8176 SEPARATION OF ^{140}La, ^{152}Eu, ^{90}Sr, AND ^{90}Y FROM URANIUM BY CHROMATOGRAPHY ON PAPER IMPREGNATED WITH SILICOTUNGSTATES. Marcu, Gheorghe. Stud. Univ. Babes-Bolyai, Ser. Chem., 12: No. 2, 139-43(1967). (In Rumanian).

The properties of the compounds of silico-12-tungstic acid with ammonium, cesium, and thallium ions as ion exchangers with uranium, lanthanum, europium, strontium, and yttrium were studied. The conditions for separation by chromatography on paper impregnated with these compounds of uranium from ^{140}La, ^{152}Eu, ^{90}Sr, and ^{90}Y as well as of ^{90}Sr from ^{90}Y by eluation with HNO_3 of various concentrations (0.1 to 1.0 M) were determined. The ammonium salt of silico-12-tungstic acid proved to be the most suitable both for the separation of uranium from ^{140}La, ^{152}Eu, ^{90}Sr, and ^{90}Y, as well as for the separation of ^{90}Sr from ^{90}Y by eluation with HNO_3 0.1 M. Since it reduces the time of eluation from 4 to 6 hours to 1 to 1.5 hours and gives a clear separation of the compounds being studied, the method proved to be superior to all usual chromatographic methods. (auth)

8177 THE CHEMISTRY OF PROTACTINIUM. V. THE SEPARATION OF Pa(IV) AND Pa(V) BY CO-PRECIPITATION WITH THORIUM FLUORIDE. Mitsuji, Toshikazu (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 40: 2822-5(Dec. 1967).

The separation of Pa(IV) and Pa(V) was investigated using various coprecipitants which were insoluble in acidic solutions. Among them, thorium fluoride was found to be the most useful coprecipitant. Conditions for the separation of both valency states of protactinium were also investigated in detail. This method was applicable to protactinium solutions in the concentration range down to tracer level. It was difficult to reduce Pa(V) completely on a tracer scale by means of a liquid zinc amalgam. When Cr(III) was added to the system, however, the complete reduction of ^{233}Pa(V) was readily attained. It was assumed that Cr(II) formed by liquid-zinc-amalgam reduction mediates the reduction of Pa(V) and protects Pa(IV) from re-oxidation. By this method tetravalent protactinium in a perchloric acid medium was also confirmed to be very stable. (auth)

8178 THE SYNERGISTIC EFFECT IN SOLVENT EXTRACTION: THE CORRELATION OF THE IONIC RADIUS OF RARE EARTH ELEMENTS WITH THE STABILITY CONSTANTS OF RARE EARTH BENZOYLTRIFLUOROACETONATE ADDUCTS WITH n-HEXYL ALCOHOL, TBP, AND TOPO. Shigematsu, Tsunenobu; Tabushi, Masayuki; Matsui, Masakazu; Honjyo, Takaharu (Kyoto Univ.). Bull. Chem. Soc. Jap., 40: 2807-12 (Dec. 1967).

The synergistic effects of n-hexyl alcohol, TBP, and TOPO on the extraction of rare earth ions with benzoyltrifluoroacetone in benzene were studied. The stability constants of the adducts were determined by means of the curve-fitting method. The equation based on the shift of $pH_{1/2}$ ($-\Delta pH_{1/2}$) was also employed to analyze the data. The results are discussed in relation to the ionic radius of rare earth elements and herein summarized. The stability of rare earth benzoyltrifluoroacetonate decreased but that of the adducts increased as the ionic radius increased. The maximum number of base molecules bonding to one molecule of the metal chelate was 2, except that in the case of lutetium adduct with TOPO where the formation of secondary adducts was not observed. Although the overall stability constant of the adduct increased in the following order; lutetium < terbium < europium < lanthanum, as mentioned above, the first stability constant did not show such a distinct sequence. Therefore the contribution of the second stability constant seemed to be an important factor. Organic bases studied formed stable adducts with rare earth benzoyltrifluoroacetonates in the following order: n-hexyl alcohol < TBP < TOPO. This order corresponds to the donating power of lone pair electrons of the oxygen atoms in these compounds. (auth)

8179 CONTRIBUTION TO THE DEVELOPMENTAL RESEARCH ON NUCLEAR MATERIALS IN THE UNITED ARAB REPUBLIC. Farah, Michel Y. (Atomic Energy Establishment, Cairo). Energ. Nucl. (Paris), 9: 314-22(Aug.-Sept. 1967). (In French).

Major research trends undertaken during the last decade pertaining to nuclear materials development from national resources in the UAR are reviewed. The studies involve: consideration of economic minerals of Rosetta placers specially monazite flotation; processing of monazite by sulfuric acid, soda chalk, or chlorine, followed by various fractionations; ion-exchange separation of nuclear-purity uranium from monazite digests and liquors; tributyl phosphate refining of thorium and examination of its variables; trilaurylamine and octylphosphoric solvents for refining uranium from monazite; ultimate upgrading of high-purity zircon; analyses, comminution enrichment, grindability, and flotation of uranium-bearing phosphates of gebel Katrani (Fayoum); and leaching of run-of-mine sandstones followed by trials on the ion-exchange fixation of uranium on some habitual resins. Some pilot installations pertaining to nuclear materials elaboration and refining are described. (auth)

8180 APPARATUS FOR THE THERMAL DIFFUSION SEPARATION OF STABLE GASEOUS ISOTOPES. Rutherford, W. M.; Weyler, F. W.; Eck, C. F. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. Rev. Sci. Instrum., 39: 94-100(Jan. 1968).

An efficient and easily fabricated thermal diffusion column design was developed for the thermal diffusion separation of stable isotopes. The design is based on the use of commercial tubular electric heaters for the hot wall. As many as 18 of these columns can be placed in a common cooling water jacket. Tests of a prototype column with argon, methane, and xenon gave results in reasonably good agreement with theory. Application of the column design and associated equipment and techniques was demonstrated by the successful operation of a 24-column 6-stage cascade for enriching ^{124}Xe. (auth)

8181 ENGINEERING DEVELOPMENT OF A FLUIDIZED-BED FLUORIDE VOLATILITY PROCESS. PART III. BENCH-SCALE STUDIES WITH IRRADIATED URANIUM ALLOY FUELS. Chilenskas, A. A.; Turner, K. S. (Argonne National Lab., Ill.). Nucl. Appl., 4: 6-16(Jan. 1968).

In six experiments using fluidized-bed fluoride volatility techniques to process irradiated uranium–Zircaloy and uranium–aluminum alloy fuels, less than 1% of the U was retained in the reactor and filter beds. Decontamination factors for Ce, Sr, Cs, Ru, Sb, Zr, and Nb ranged from 3.5×10^5 to 1×10^8 but were 5.9×10^4, 44.6, 3.5, and 2.9 for Te, Mo, Np, and Tc, respectively. Principal volatile fission product chlorides are Zr, Nb, Kr, and I; partially (<10%) volatile chlorides are Sb, Te, Mo, and Tc; nonvolatile chlorides are Ce, Cs, Sr, and Ru. The fluorides of Sb, Mo, Tc, Np, Nb, and Te are highly volatile but those of Ce, Cs, Sr, Zr, and Ru are nonvolatile. Iodine and krypton volatilized completely during the hydrochlorination step, and the iodine was removed completely from the process off-gas by a caustic scrubber. Tellurium was removed completely from the process off-gas with activated alumina. (auth)

8182 ISOTOPE SEPARATION BY CARRIER DIFFUSION. Craig, H. (Scripps Institution of Oceanography, La Jolla, Calif.). Science, 159: 93-6(Jan. 5, 1968).

Nitrogen isotope fractionation in the Hoering-Moore experiment, injection of N_2 into CO_2 carrier and flow through sandstone, is due to diffusion in the gas phase rather than to surface interaction. This process, called "carrier diffusion," produces a characteristic fractionation pattern relative to a fraction coordinate, with points of zero fractionation at 16 and 84% and heavy isotope enrichment between these points. Carrier diffusion is an efficient enrichment process for low-abundance isotopes lighter than the abundant species and for helium and hydrogen in gas mixtures. (auth)

8183 RAPID SEPARATION OF ^{90}Sr–^{90}Y, ^{212}Pb–^{212}Bi BY THIN LAYER ELECTROPHORESIS ON SHORT CUT PIECES OF CHROMATOSHEET. Mori, Itushiko (Kobe Coll. of Pharmacy, Japan). Bunseki Kagaku, 12: 1320-3(1967). (In Japanese).

Radioactive parent–daughter pairs, ^{90}Sr–^{90}Y and ^{212}Pb–^{212}Bi, were mutually separated and identified by thin-layer electrophoresis on cut pieces, 5 cm × 2 cm, of Chromatosheet (Silica gel, Toyo Filter paper Co.). The electrophoresis is carried out 5 min with 300 V/5 cm, using 0.15M citric acid as the electrolyte. The samples are spotted at 1 cm from the cathodic end of the Chromatosheet. The merits in this procedure are: separated zone, compact, and clear; simple procedure and readiness of collection of the separated species; no cooling necessary and high reproducibility; and economy (40 pieces out of one sheet, 20 × 20 cm), and free from radioactive staining of the apparatus by discarding the waste pieces. The method is convenient for the separation, especially, of ^{212}Pb and ^{212}Bi. Thorium nitrate and barium palmitate are used as the emanating source for collecting ^{212}Pb, and optimum voltage and collecting time are decided. The identification of ^{90}Sr and ^{90}Y are done by sodium rhodizonate and autoradiography, and that of ^{212}Pb and ^{212}Bi are by dithizone–chloroform extraction followed by the activity measurement using a 2π gas flow counter with Q gas. (auth)

8184 ISOTOPIC ENRICHMENT OF NITROGEN IN THE PHOTOLYSIS OF NO. Schmidt, C. F.; Reeves, R. R. Jr.; Harteck, Paul (Rensselaer Polytechnic Inst., Troy, N. Y.). pp 1-8 of International Conference on Photochemistry, Sept. 6–9, 1967, Munich. Part I and II. Munich, Max-Planck-Institut fuer Kohlenforschung, 1967.

See CONF-670954–(Pt. I and II).

Photolysis of NO in the vacuum ultraviolet yielded N_2, O_2, NO_2, and N_2O. When the photolysis was carried out using the 1633 A line of bromine, the N_2 initially formed was found to be enriched in ^{15}N. The dependence of the enrichment on several parameters was studied, including temperature, pressure, the initial isotope ratio, and inert gases. The enrichment of the N_2 in $^{15}N^{14}N$ over $^{28}N_2$ produced in the photolysis was due to relatively more ^{15}NO being excited, and reacting before isotope scrambling occurred by energy transfer. (auth)

8185 RESEARCH AND DEVELOPMENT ON AQUEOUS PROCESSING. Stevenson, C. E.; Paige, D. M. Power Reactor Technol. Reactor Fuel Process., 10: 152-9(Spring 1967).

Modifications were made to broaden the applications of the HF dissolution process for zirconium-alloy fuels, and methods were developed for acid dissolution of uranium in by-products of pyrochemical processing. The effects of variables in ThO_2 dissolution were examined. A single-cycle extraction process appears to be applicable to provide recycle material for semiremote fabrication of thorium fuels. Small amounts of dibutyl phosphate (DBP), resulting from the radiolysis of tributyl phosphate (TBP), markedly affect the distribution coefficients of zirconium and plutonium in Purex-type processes. Neptunium is being recovered from fuel processing at the Idaho Chemical Processing Plant (ICPP). A process for cation-exchange concentration of ^{235}U was developed, as well as a method for dissolving waste resins damaged by radiation. Hot-cell processing of a batch of irradiated fuel containing Zr, Fe, Cr, Ni, and NaK is described, and plant equipment for the electrolytic production of a tetravalent uranium solution for plutonium reduction is characterized. (auth)

8186 VOLATILITY PROCESSES. Barghusen, J. J. Power Reactor Technol. Reactor Fuel Process., 10: 160-4 (Spring 1967).

Fluoride-volatility processing of UO_2-PuO_2 fuel, fluorination of materials with fluorine and interhalogens, complex fluorides of actinide elements, and properties of volatile fluorides are discussed. (M.C.G.)

8187 COMPACT PYROCHEMICAL PROCESSES. Johnson, T. R. Power Reactor Technol. Reactor Fuel Process., 10: 165-9(Spring 1967).

Several pyrochemical processes are being studied in which separations of fuel materials from fission products are done principally by extractions between metal and salt phases. Salt-transpot processes, alternative processes for molten salt breeder reactor fuel, slagging processes, integrated process for a liquid-metal fuel reactor, and electrolytic processes in liquid salts are discussed. (M.C.G.)

8188 REVISED REGULATION ON NUCLEAR FUEL PROCESSING ENTERPRISE: JAPAN. Loeding, J. W. Power Reactor Technol. Reactor Fuel Process., 10: 173-5(Spring 1967).

A comparison was made, where feasible, of the revised version of Japanese Regulations on Nuclear Fuel Processing Enterprise with the AEC Rules and Regulations governing the same scope. (M.C.G.)

8189 PROGRESS IN WASTE-DISPOSAL RESEARCH AND DEVELOPMENT. Fineman, Phillip. Power Reactor Technol. Reactor Fuel Process., 10: 176-9(Spring 1967).

Incorporation of intermediate-level-activity wastes in asphalt, the phosphate-glass process for conversion of high-level-activity wastes to solids, disposal by hydraulic fracturing into shale, calcined storage in salt mines, and thermal analysis of buried tanks containing solidified radioactive wastes are discussed. (M.C.G.)

8190 COLUMN CHROMATOGRAPHIC SEPARATION OF NIOBIUM, TANTALUM, MOLYBDENUM, AND TUNGSTEN. Fritz, James S.; Dahmer, Lionel H. (Ames Lab., Iowa). Anal. Chem., 40: 20-3(Jan. 1968).

Distribution ratios are reported for extraction of niobium(V), tantalum(V), molybdenum(VI), and tungsten(VI) into methyl isobutyl ketone from various aqueous mixtures of hydrofluoric, hydrochloric, and sulfuric acids. Quantitative separations cannot be obtained by simple batch extractions, so a column chromatographic technique was employed using a Teflon-6 support impregnated with methyl isobutyl ketone. Sequential elution with eluents of different compositions separates niobium(V) and tantalum(V), molybdenum(VI), and tungsten(VI), and a mixture of all four elements from each other. Using radioactive tracers, as little as 0.1 ppM of one metal was separated from the others. (auth)

8191 ZONE REFINING FOR THE SEPARATION OF RADIOACTIVE TRACE CONTAMINANTS FROM ORGANIC COMPOUNDS. Diehn, Bodo; Rowland, F. S.; Wolf, A. P. (Univ. of Kansas, Lawrence. Brookhaven National Lab., Upton, N. Y.). Anal. Chem., 40: 60-4(Jan. 1968).

The purification by zone refining of propionamide containing traces of radioactive acetamide as impurity was studied because of the particular difficulties involved in the separation of homologous solid compounds if conventional methods are used. The separation efficiency was determined quantitatively as a function of travel speed of the liquid zone, number of zone passes, and impurity concentration. With the automatic zone refining apparatus described, the concentration of acetamide in propionamide was readily reduced by 10^4 from its original concentration of 0.02% with a minimum of handling of the sample. The technique offers particular advantages in studies of nuclear recoil reactions in solid substances, and in other situations in which traces of very high specific activity contaminants are encountered. (auth)

8192 STUDIES OF THE MECHANISM OF EXTRACTION OF NUCLEAR FUEL FROM CANS. Raviv, S.; Gabriel, I. (Atomic Energy Commission, Neguev, Israel). J. Nucl. Mater., 24: 281-99(Dec. 1967). (In French).

A study was made of galvanic and cathodic corrosion at the interface between nuclear fuel and cans of stainless steel, Zircaloy, and aluminum. The corrosion rate was determined as a function of cathodic current density, nitric acid concentration, and temperature. The EMF of the fuel/can cell and the variations of EMF with acid concentration and current density were determined. In $5.4\underline{N}$ nitric acid, the uranium potential rose sharply, probably owing to the formation of a "double layer." Interfacial corrosion liberated N_2O, N_2, H_2, and O_2 in the cathodic region. The results can be regarded as galvanic dissolution of uranium in a uranium/can cell, to a degree determined by the EMF of the cell. The dissolution of the fuel takes place at a regular rate along the fuel/can interface; radiography confirmed this. Such dissolution allows irradiated fuel (uranium or uranium compounds) to be extracted from its can (stainless steel, Zircaloy, or aluminium) without the necessity of dissolving the can. This method can reduce the expense of treating irradiated nuclear fuels by reducing the volume of effluent of medium activity that would result from that operation. Moreover, this allows fuels to be treated irrespective of the material of which the can is made. (auth)

8193 THE USE OF 1-PHENYL-3-METHYL-4-CAPRYL-PYRAZOLONE-5 IN LIQUID–LIQUID EXTRACTION METHOD FOR THE CARRIER-FREE PRODUCTION OF ^{54}Mn, ^{58}Co, ^{59}Fe. Mirza, M. Y. (Atomic Energy Commission, Riso, Denmark). Int. J. Appl. Radiat. Isotop., 18: 849-56(Dec. 1967).

The extraction of Fe^{3+}, Cr^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+}, and Zn^{2+} from aqueous solutions at various pH into methyl isobutyl ketone containing 1-phenyl-3-methyl-4-capryl-pyrazolone-5 was investigated. The quantitative extraction of Mn^{2+} and Co^{2+} ions at pH 5.4 to 7.3 and that of Fe^{3+} at pH 2.8 was utilized for the carrier–free separation of these activities produced by $^{54}Fe(n,p)^{54}Mn$, $^{58}Ni(n,p)$-^{58}Co and $^{59}Co(n,p)^{59}Fe$ reactions, respectively. Good decontamination factors and 90 to 93% ^{54}Mn, 90% ^{59}Fe and 80 to 85% ^{58}Co recoveries were obtained. (auth) (UK)

8194 EXPERIMENTAL VERIFICATION OF THE NATURAL DISTRIBUTION OF BORON ISOTOPES. Shergina, Yu. P.; Kaminskaya, A. B. (All-Union Scientific-Research Inst. of Prospecting Methods and Techniques, Leningrad). Geokhimiya, No. 10, 1111-15(Oct. 1967). (In Russian).

By passing boron-containing solutions through columns 1.8 m long filled with very porous clay, owing to the filtration effect and sorption of boron by clay minerals, a significant separation of boron isotopes (2.3% of the original ratio $^{11}B/^{10}B$ enrichment in ^{11}B) was obtained. The result is analogous with the change in $^{11}B/^{10}B$ observed in zones of tectonic disturbances, and verify the possibility of natural fractionation of boron isotopes. (tr-auth)

8195 DETERMINATION OF THE PARTITION COEFFICIENT FOR THE VOLUME DISTILLATION PROCESS OF THE $(CH_3)_2O.BF_3$ COMPLEX. Kaminskii, V. A.; Karamyan, A. T.; Partsakhashvili, G. L. At. Energ. (USSR), 23: 244(Sept. 1967). (In Russian).

The volume distillation of the $(CH_3)_2O \cdot BF_3$ complex is the best industrial process for the concentration of boron isotopes. In order to clarify the contradictory data in the literature concerning the partition coefficient, the process was investigated at temperatures between 100 and 127°C. The vapors of the complex dissociate into BF_3 and dimethyl ether; the separation is determined by the value of the effective coefficient, α_{eff}, related to the equilibrium constant of the isotopic exchange reaction. The tests involved the simultaneous determination of the partition coefficient and of the number of stages by analyzing the enrichment in the 30-mm-diameter, 1.5-m-high column. The mean calculated values of α_{eff} and the equilibrium constant K were: at 100°C, $\alpha_{eff} = 1.011$; K = 1.018; at 127°C, $\alpha_{eff} = 1.015$; K = 1.015. The K values obtained agreed with those reported by A. Palko et al., Holmberg, and M. Kilpatrick et al. (TTT)

8196 ADSORPTION METHOD FOR THE SEPARATION OF PROTACTINIUM ISOTOPES. Sakanoue, Masanobu; Abe, Masao (Kanazawa Univ., Japan). Radioisotopes (Tokyo), 16: 645-51 (Dec. 1967).

A procedure, based on the selective adsorption of radionuclides on glass, was worked out for the separation of ^{233}Pa from irradiated thorium and for the removal of ^{231}Pa target from ^{232}U. The adsorption of protactinum from highly concentrated nitric acid solution was examined by using the batch method. Adsorbents used were quartz sand, glass powder, and silica gel. Carrier-free ^{233}Pa was successfully prepared from irradiated thorium in $10\underline{M}$ HNO_3 solution by adsorption on column containing glass powder, followed by the elution with $8\underline{M}$ HCl−$0.015\underline{M}$ HF solution. By a similar procedure, ^{232}U produced by irradiation of ^{231}Pa was obtained effectively from the highly α-radioactive target materials. (auth)

8197 SEPARATION OF ^{90}Sr, ^{89}Sr, and ^{140}Ba FROM THE ASH OF CATTLE BONES, MILK, AND FISH. Niepel, J. (Veterinaeruntersuchungs-Tiergesundh., Potsdam, Ger.). Z. Lebensm.-Untersuch. Forsch., 128: No. 3, 144-53(1965). (In German).

A method is described for the separation of ^{89}Sr, ^{90}Sr, and ^{140}Ba from ashed bone, fish meal, and milk. The method is based on the solubility of Sr and Ba nitrates in nitric acid at concentrations of 65 to 71%. Recoveries of 90 to 93% were possible. (B.H.S.)

8198 PLUTONIUM HANDBOOK. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967. 454p.

Fifteen chapters are included; a separate abstract was prepared for each. (P.C.H.)

For abstracts of individual chapters see: 8032–8034, 8199–8202, 8327, 8333, 8490, 8557, 8714, 8715, 8804, and 8810.

8199 SEPARATION FROM IRRADIATED URANIUM. Cleveland, J. M. (Dow Chemical Co., Golden, Colo.). pp 521-52 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Descriptions are given of processes for the separation of Pu from irradiated U. Each is discussed from the standpoint of Pu recovery, with little attention to U purification. The methods include: Purex process; ion exchange; precipitation; and pyrochemical and pyrometallurgical processes. Solvent extraction, being most important, is covered in greater detail than the earlier processes, now of historical interest; the nonaqueous pyrochemical and pyrometallurgical processes, which have yet to be proved, are discussed only briefly. In each case the process flow sheet begins with a HNO_3 solution of Pu, U, and fission products. (63 references). (P.C.H.)

8200 PLUTONIUM RECOVERY AND WASTE DISPOSAL. Cleveland, J. M. (Dow Chemical Co., Golden, Colo.). pp 573-84 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Methods for plutonium recovery, such as liquid and solid waste processing, solvent extraction, and anion exchange, are discussed, along with processes for plutonium waste disposal. (P.C.H.)

8201 DESIGN OF EQUIPMENT AND FACILITIES. Merker, L. G. (Battelle Memorial Inst., Richland, Wash.). pp 859-73 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Chemical and metallurgical equipment and facilities for processing and utilizing plutonium are described. This included plant design and location relationship, chemical separation plants, and glove-box facilities. Special emphasis is placed on the design criteria for future plutonium processing facilities that will undoubtedly be used for the fabrication and reprocessing of power reactor fuels. (P.C.H.)

8202 NUCLEAR SAFETY AND CRITICALITY OF PLUTONIUM. Clayton, E. D.; Reardon, W. A. (Battelle Memorial Inst., Richland, Wash.). pp 875-919 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Data and techniques that have been used to evaluate the problems of criticality in typical plutonium processing and fabrication plants are described. Recommendations concerning the reliability of the data and techniques of control are also discussed. (68 references). (P.C.H.)

8203 SINGLE-CYCLE IRRADIATED FUEL REPROCESSING. Anderson, Cleve R. (to General Electric Co.). U. S. Patent 3,357,802. Dec. 15, 1965.

A method for treating an aqueous solution of irradiated nuclear fuel comprises subjecting the solution to a single-cycle extraction with an organic solvent in the presence of an aqueous salting agent to produce an organic extractant stream containing substantially all of the fissionable−fertile materials and a minor proportion of fission products including at least one fission product selected from the class consisting of Ru, Zr, and Nb; treating the organic extractant to remove substantially all of any fissionable−fertile materials other than U; further treating the organic extractant to form an aqueous extract stream containing U and the selected fission products; dehydrating the aqueous extractant stream to form anhydrous UO_3 and fission product oxides; directly fluorinating the UO_3 and fission product oxides with F_2 to form UF_6 and the corresponding fission product fluorides; and separating the relatively low boiling UF_6 from the relatively high boiling fission product fluorides. (U. S. Pat Office Gaz.)

8204 PROCESS OF EXTRACTION OF HAFNIUM. de Calmes, Alain; Humeau, Henri; Lecocq, Alfred (to Commissariat a l'Energie Atomique). U. S. Patent 3,346,330. Dec. 12, 1962. Priority date Dec. 27, 1961, France.

A process for separation of Hf from Zr and impurities comprises completely emulsifying an aqueous acid solution containing Hf, Zr, and impurities with an organic solvent; the acidity of the acid solution is greater than $7\underline{N}$ but not so great as to attack the organic solvent; the emulsion is allowed to separate into an upper organic phase containing a substantial amount of Hf and Zr, a lower aqueous phase, and a sludge innerlayer. The aqueous phase and the sludge innerlayer contain most of the impurities. The organic phase containing the Hf and Zr is separated from the phases containing the impurities, and the organic phase is passed countercurrent to an aqueous acid solution having an acidity such that the partition coefficients are different for Hf and Zr. By this means the Hf passes into the aqueous acid phase and most of the Zr remains in the organic phase. (U. S. Pat. Office Gaz.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 8240, 8322, and 8404.

8205 (BNWL–628) TEST SIMULATION OF THE TEMPERATURES OF THE DEERFIELD RIVER. Jaske, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 41p. Dep. CFSTI.

A study was made to determine whether a mathematical system could simulate the temperature fluctuations in the Deerfield River from a point 5 miles below the Yankee Power Reactor to a downstream location near the confluence with the Connecticut River. Data required for the operation of the temperature model included water temperature records from 1958, river flow measurements, meteorological measurements, river dimensions, and advective heat quantities from the reactor installation. Tests performed for each simulation run indicated a minimum 68% accuracy of correlation with measured data. The program successfully demonstrated the capability of the simulation system in a wide range of environmental situations with routinely available field data. (L.C.L.)

8206 (BNWL–CC–208) ADSORPTION, MIGRATION, AND DISPERSION OF STRONTIUM AND CESIUM IN AN N-AREA SOIL. Hajek, B. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 7, 1965. Contract AT(45-1)-1830. 20p. Dep. CFSTI.

Experimental and mathematically derived results are presented which characterize the adsorption, migration and dispersion in an N-Area soil of Sr and Cs present in a simulated emergency waste water. Experimental results from laboratory soil columns and equilibrium studies showed that the soil at the proposed disposal site is more selective for Cs than Sr. The distribution coefficients were 420 and 43 ml/g for Cs and Sr respectively. Extrapolation of column breakthrough data showed that 42 and 12 column volumes of influent were required for 0.01 percent breakthrough for Cs and Sr respectively. Calculations based on theoretical equations and equilibrium distribution coefficients indicated that the average migration rate of Cs through a soil column should be $^1/_{10}$ the rate of Sr. The actual migration rate of Cs through the column was $^1/_{11}$ of the Sr rate. Migration rates in ground water were determined relative to ground water movement: Migration rate of Sr = $^1/_{100}$ rate of ground water movement, and Migration rate of Cs = $^1/_{1000}$ rate of ground water movement. Diffusion coefficients determined for Sr and Cs in soil material indicate that spreading of these adsorbed radionuclides by this mechanism is negligible. The average infiltration rate was determined to be 170 gpd/ft^2. (auth)

8207 (TID–24124) HISTORIC SURFACE FAULTING IN CONTINENTAL UNITED STATES AND ADJACENT PARTS OF MEXICO. A Factor in Nuclear Facility Siting and Design. Bonilla, M. G. (National Center for Earthquake Research, Menlo Park, Calif.). 1967. 36p. Dep. CFSTI.

Approximately 35 instances of historic faulting of the ground surface in the continental USA and adjacent parts of Mexico are summarized: This information is of importance in the selection and evaluation of sites for vital structures such as nuclear power plants. Several tentative conclusions were reached on the basis of this preliminary study of historic surface faulting: branch and secondary faulting commonly accompanies the main faulting. About half of the more than 30 main ruptures of undoubted tectonic origin had branch and secondary ruptures associated with them; the main fault zone and the zones of branch faults and of secondary faults are narrower for strike-slip faults than they are for normal faults, reverse faults, or dextral-normal faults; a total of seven ruptures, associated with three earthquakes generated by normal, dextral-normal, and reverse faults, occurred 7.5 to 8.5 miles from the main faults. The displacements ranged from 0.3 ft to 4 ft and were equivalent to 3.5 to 17% of the maximum displacement on the main fault; the displacements on individual branch and secondary faults were less than 30% as large as the displacement on the main fault, with three doubtful exceptions that ranged between 50 and 80%; with one possible exception, the main faulting occurred along faults that were, or could have been identified beforehand by geologic means. The possible exception is the Sonora, Mexico faulting 1887, for which data are incomplete; and one-third of the branch and secondary faulting covered in this study is known to have occurred on preexisting faults that could have been identified by simple geologic investigations; whether the other two-thirds could have been also is not known. (R.C.K.)

8208 AGE OF THE EARTH CRUST AND DYNAMICS OF RADIOGENIC GASES (^{4}He AND ^{40}Ar) SUPPLY TO THE ATMOSPHERE. Baranov, V. I.; Knorre, K. G. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 12, 1418-29(Dec. 1967). (In Russian).

The Earth crust appeared soon after the Earth formation and was preserved further on the character of a closed system for U and Pb. The present ^{4}He supply to the Earth atmosphere may be explained by the loss of 5% of helium being formed during uranium and thorium decay in the Earth crust. The absence of a substantial inflow from the mantle is confirmed by the value of the Ar/He ratio in natural gases being typical of rocks of the Earth crust (Ar/He 1) and not of mantle (Ar/He 1). A considerable part of ^{40}Ar appears to be supplied to the atmosphere as a result of degassing of the protoplanetary matter during the process of Earth formation. (auth)

8209 CHARACTER OF RADIUM AND URANIUM BOND IN PEAT. Titaeva, N. A. (Moscow State Univ.). Geokhimiya, No. 12, 1493-9(Dec. 1967). (In Russian).

In little-mineralized hydrocarbonate-calcic surface waters uranium is considerably more mobile than radium. Radium is well sorbed not only by clay sediments but also by peat. In peat uranium is bound to the fraction of humic acids and fulvoacids being soluble in alkalis, and radium to the insoluble residue. The bond of elements under oxidizing conditions has an exchange character. In the presence of great calcium amounts in water the radium bond in peat and in the insoluble residue becomes poorly exchangeable. In humic acid the exchange character of the radium bond is preserved. (auth)

8210 RADIOCARBON CONTENT OF MARINE SHELLS FROM THE PACIFIC COASTS OF CENTRAL AND SOUTH AMERICA. Taylor, R. E.; Berger, Rainer (Univ. of California, Los Angeles). Science, 158: 1180-2(Dec. 1, 1967).

The radiocarbon content of contemporary pre-bomb marine shells from the region of upwelling of the Pacific coast of South America has been determined and found to be somewhat similar to the content of shells from the coast of California and the west coast of Mexico. Deviations of up to −8.5 percent with reference to the contemporary biospheric carbon-14 standard have been observed for the Peruvian coast. Values of from −0.35 to −4.04 percent have been obtained for marine shells from the Galápagos group. Problems associated with radiocarbon dates based on shells are discussed. (auth)

8211 ANOMALIES IN THE RADIOACTIVITY OF THE TASHKENT MINERAL WATERS DURING 1965 AND 1966. Mavashev, B. Z. (Uzbek State Scientific-Research Inst. of Physical Therapy, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 5, 38-9(1967). (In Russian).

The radon concentration of ground waters depends on the radium content of the surrounding rocks and a special emanation coefficient. It has been noted that this coefficient changes when the rocks are subjected to tectonic destruction. The measurements were made before and after earthquakes, determining the radon content of the Tashkent mineral water. The noted anomalies coincided with the earthquake induced physico-mechanical changes of the rocks. Increase of the radon concentration before the earthquake is probably due to the buildup of elastic stresses in the rocks, forcing out the radon; reduction of the radon content after the earthquake to a quasistationary level may be attributed to the release of the stored energy, inhibiting the passage of the gas from the rocks into the water. There is thus a definite correlation between the radon concentration of mineral waters and tectonic phenomena in the Earth's core. (TTT)

8212 A COMPARISON BETWEEN ETCHED FISSION TRACK DENSITIES ON INTERNAL AND EXTERNAL GLASS SURFACES AFTER NEUTRON IRRADIATION. Edwards, J. (Univ. of Liverpool). Geophys. J., 13: 541-3(Nov. 1967).

Fission track densities, revealed in an obsidian by etching, have been studied as a function of etching time after the obsidian had been irradiated by neutrons in a reactor. Whereas the etched fission track density observed in an external surface increases at first with progressive etching, the fission track density revealed on what was an internal surface during irradiation remains more or less independent of etching treatment. (auth)

8213 RADIOMETRIC AGES OF PLEISTOCENE FOSSILS FROM CAYUCOS, CALIFORNIA. Veeh, H. Herbert; Valentine, James W. Geol. Soc. Amer., Bull., 78: 547-50(Apr. 1967).

The U and Th contents and ages based on ^{230}Th/^{238}U were determined in two Pleistocene fossils: a solitary coral (Balanophyllia) and a chiton (Cryptochiton). Since the concentration of

U is very low in living chitons, most of the U (2.3 ppM) found in the fossil chiton appeared to be of secondary origin. The ^{234}U/^{238}U ratio of 1.31 not only confirmed this but also showed that the secondary U was derived mainly from continental waters where the ratio is characteristically higher than the average value of 1.15 reported for marine waters. Thus, the estimated age, 140,000 ± 30,000 yr, was based on the assumption that the secondary U was added to the chitons shortly after the death of the organisms. The ^{234}U/^{238}U ratio in the fossil coral (1.15 ± 0.02) was only slightly higher than would have been expected (1.10 ± 0.02) if the U had been derived from sea water during the lifetime of the coral. Since living corals contain from 2 to 4 ppM U, secondary U (4.2 ppM) in the fossil coral probably constitutes only a small proportion of the total U content and consequently did not seriously affect the ^{230}Th age estimates. Both ages should be considered as minimum ages, the age of the coral being the more reliable one. The insignificant ^{232}Th content of the material studied indicated that the ^{230}Th arose in the fossils by radioactive decay of U. (BBB)

8214 FIRST APPLICATION OF NEUTRON PROBE FOR THE DETECTION OF A STABLE TRACER (Cd) IN HYDROGEOLOGY. Pirastru, E.; Carlin, F.; Dai Pra, G. (CNEN, Bari, Italy). pp 279-97 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The basic principles on which the use of a neutron probe is based are outlined. The laboratory and field experiments on the calibration of neutron probes to be used for the determination of the water content in soils were described. The advantages of Cd as a tracer for hydrogeological measurements are outlined. In appendices the calculation of the neutron density decrease with respect to that of pure water caused by emission of from 1 to 2 g/l of Cd, and the calculation of the calibration curve for Cd with the least squares method are given. (J.S.R.)

8215 ^{90}Sr AND ^{137}Cs IN SOME AUSTRALIAN DRINKING WATER SUPPLIES: 1961–1965. Bonnyman, J.; Molina-Ramos, J. (Commonwealth X-ray and Radium Lab., Melbourne). Aust. J. Sci., 30: 171-2(Nov. 1967).

Measurements of ^{90}Sr and ^{137}Cs in Australian water samples are described and results presented in tables. (M.C.G.)

8216 ON THE RADIOACTIVE INTENSITY OF THE NEOGENE TERTIARY IN THE VICINITY OF SHIBATA CITY, NIIGATA PREFECTURE. Bojo, Toshiatsu; Matsui, Hiroshi (Geological Survey of Japan). Chishitsu Chosasho Geppo, 17: 472-9(Aug. 1966). (In Japanese).

The results of a radiometric survey and geologic investigation of the Neogene Tertiary in the vicinity of Shibata City, Japan, are described. The geology in this area is divided into several formations. Among those formations, the Yamanokami conglomerate overlies unconformably the granite named Kusozu–Kogawa type and its thickness is ~550 to 650m in the southern part of this area. This formation is composed chiefly of coarse arkosic materials and abundant thin coal seams. The other Neogene Tertiary in this area consists mainly of some fine-grained sediments (mudstone, very fine sandstone etc.) intercalating acidic pyroclastic rocks. The distribution and variation of radioactive intensity of each formation measured by scintillation counter are shown. Radioactive intensities of each formation are represented as the value of ratio, at outcrops of each rock to natural background in radioactive intensity. The ratio of intensity in both the Kusozu–Kogawa granite (1.97) and the Yamanokami conglomerate (1.82) is larger than in the other formations. Uranium was not detected by chemical analysis of three samples from the Yamanokami conglomerate which has the maximum ratio of nearly 3.0. (NSA of Japan)

8217 RADIOACTIVE ANOMALIES IN THE COAL-BEARING MIOCENE SEDIMENTS OF THE IGU LIGNITE FIELD, MIYAGI PREFECTURE, NORTHEAST JAPAN. Sugai, Kanji; Hoshino, Kazuo (Geological Survey of Japan). Chishitsu Chosasho Geppo, 17: 480-90(Aug. 1966). (In Japanese).

There are two localities of radioactive anomaly in the Igu lignite field. One is in the working lignite seam 150cm thick, which is found ~20 to 50 m above the granitic basement rocks. The other is in the lignitic mudstone, 130cm in thickness, which is found 10m lower from the lignite seam. Both seams are Miocene in age. Maximum radioactive intensity and content of U_3O_8 of the former are six times as standard and 0.039%, while maximum radioactive intensity of the latter is fourteen times, and content of U_3O_8 is 0.074%. Radioactive intensity of the seams is very variable both horizontally and vertically. (NSA of Japan)

8218 ON THE RADIOACTIVELY ANOMALOUS SITES DETECTED BY THE CARBORNE RADIOMETRIC SURVEY IN YAMAGUCHI AND SHIMANE PREFECTURES. Higashimoto, Sadao (Geological Survey of Japan). Chishitsu Chosasho Geppo, 17: 497-501(Aug. 1966). (In Japanese).

Radioactively anomalous sites were detected by car-mounted radiometric surveys carried out in 1963 and 1964 at Usago, Nishiki-cho, Yamaguchi prefecture and Kurinoki, Yanabara and Onobara, Kakinoki-mura, Shimane Prefecture. At the sites, radioactive anomalies are restricted to sinter deposits and radioactive mineral spring water flowing from fissures in granitic rocks. According to chemical analysis, no uranium is detected in the sinters. (NSA of Japan)

8219 RADIATION DOSIMETRY FROM THE NATURAL THERMOLUMINESCENCE OF FOSSIL SHELLS. Johnson, Noye M. (Dartmouth Coll., Hanover, N. H.); Blanchard, Richard L. Amer. Mineral., 52: 1297-1310(Sept.-Oct. 1967).

Absolute radiation dosimetry may be obtained from natural materials using the principles and techniques developed and utilized in medical and radiation physics. The problems peculiar to natural thermoluminescence dosimetry are: post-irradiation calibration techniques, dose equivalency factors, and secular equilibrium effects. These problems are illustrated and solutions are suggested by a study of naturally thermoluminescent mollusk shells. The dose equivalence and dose rates measured in these shells agree well with the known radioactivities of these materials and environments. It is suggested, therefore, that the natural radiation dosimetry of post-Pliocene calcites may be used as a basis for relative age and time correlations. (auth)

Meteorology

Refer also to abstract 10120.

8220 (COO-1199-14) STUDY OF RAINOUT OF RADIOACTIVITY IN ILLINOIS. Sixth Progress Report. Huff, F. A.; Bradley, W. E.; Feteris, P. J. (Illinois State Water Survey, Urbana). Nov. 1967. Contract AT(11-1)-1199. 19p. Dep. CFSTI.

Data on tritium sampling in 1966 and 1967 and radon sampling in 1967 are given. Spatial and time separation between air and water samples used preclude strong correlation in the investigation of the relation between concentration and deposition of radioactivity in rainwater and air. Studies of selected 1963 storms in which heavy concentrations of rainout were measured are described. These studies are being conducted to analyze air trajectories and to clarify processes controlling rainwater. Studies of the time distribution of radioactivity and chemical constituents in rainfall do not permit any conclusions to be drawn on the radioactive input processes in convective storms because to date the amount of data analyzed is insufficient. A workshop on tritium applications in atmospheric sciences is described. (F.S.)

8221 (EUR-3602) RESULTS OF ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS IN THE COMMUNITY COUNTRIES IN 1966. AIR; FALLOUT; WATER. (European Atomic Energy Community). 1967. 70p. (In Several Languages). Dep.

Results of the measurements carried out in 1966 by the member States at the environmental radioactivity monitoring stations, together with certain data obtained at Euratom's Joint Research Center, Ispra, are presented. Included are an introductory note and three sections dealing with measurements of radioactivity in the air at ground level, in fallout and in water. Most of these measurements relate to total beta radioactivity. The measurement results for certain specific radionuclides are also given as well as the amount of precipitation observed at fallout sampling stations. Graphs are given to show the pattern followed throughout the year, a comparison being drawn with the development over the years 1962, 1963, 1964, and 1965, as well as with the situation in 1966 in the United States and Canada. (auth)

8222 (ORO-2529-15) ATMOSPHERIC RADIOCHEMISTRY. Annual Progress Report. (Arkansas Univ., Fayetteville. Dept. of Chemistry). Dec. 31, 1967. Contract AT(40-1)-2529. 73p. Dep. CFSTI.

Research is reported on fallout from the June 17, 1967, Chinese nuclear explosion, radiostrontium fallout from the Chinese nuclear explosions of December 28, 1966, and June 17, 1967, variations of the atmospheric radiostrontium isotope ratio caused by the Chinese nuclear explosions during 1964 through 1966, radiocerium concentrations in ground-level air after the nuclear explosion of May 9, 1966, symmetric fission in fallout studies from May 1966 Chinese nuclear explosion, and instrumentation. (M.C.G.)

8223 (RT/PROT-(67)13) V ANNUARIO METEOROLOGICO DEL CENTRO DI STUDI NUCLEARI DELLA CASACCIA, 1966. (Fifth Annual Meteorological Report of the Center for Nuclear Studies in Casaccia). Giudici, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 25, 1967. 128p. (In Italian). Dep.

The characteristics of the Casaccia zone are briefly outlined and a general climatographic profile is given. The meteorological data with respect to the precipitation, air temperature, relative humidity, atmospheric pressure, sunshine, wind, and vertical thermal gradients are tabulated for the period between December 1, 1965, and November 30, 1966. (J.S.R.)

8224 ANALYSIS OF THE ALPHA-EMITTING RADIONUCLIDES FROM RADIOACTIVE FALLOUT BY ALPHA-SPECTROSCOPY. **Allkofer, O. C. (Univ., Kiel); Fox, J. M.; Hauser, H. Atomkernenergie, 13: 39-44(1968). (In German).**

A radiochemical analysis and evaluation by alpha spectroscopy of transuranium elements in stratospheric fallout were performed. The ratio of the alpha activity compared with the total beta activity of the fallout was 0.47%. 89% of this value were caused by plutonium, whereas 11% came from the transplutonium elements. More than 96.5% of the plutonium fraction consist of ^{239}Pu and ^{240}Pu in a not-known ratio, but both of the same order. There are 3.5% at maximum of ^{241}Pu within the plutonium fraction. By far the major part of the transplutonium fraction is represented by ^{241}Am. Samples taken from the surface of jets contained natural ^{210}Po; its activity was about four times higher than the total artificial alpha-activity. Comparing the result from the nuclear test explosion MIKE with the results of these measurements an average value can be deduced of the integral neutron flux by 1×10^{24} neutrons/cm^2 being produced by every test within the megaton range of the period 1961/62. (auth)

8225 THE EFFECT OF THE FRENCH ATOMIC TESTS ON RADIOACTIVE FALLOUT OVER THE SYDNEY AREA. **Pallister, E. T.; Carswell, D. J. (Univ. of New South Wales, Kensington). Aust. J. Sci., 30: 144-5(Oct. 1967).**

Radiochemical analyses showed a significant increase in radioactive fallout following the French nuclear tests in the South Pacific. Numerical data for rainfall and radioactive fallout for the period from June 1966 to January 1967 are given. ^{90}Sr, ^{137}Cs, and ^{144}Ce contents were determined. There was a cumulative build-up of activity, which reached a maximum in October, immediately after the conclusion of the final test. (M.C.G.)

8226 RADIOACTIVE FALLOUT FROM THE FRENCH 1966 PACIFIC TESTS. **Dyer, A. J.; Hicks, B. B. (Commonwealth Scientific and Industrial Research Organization, Aspendale, Victoria). Aust. J. Sci., 30: 168-70(Nov. 1967).**

Total beta activity was determined continuously at 24 stations throughout Australia and fission-product analyses of air samples were carried out at 5 major stations. Only trivial amounts of fallout occurred in July, August, and September 1966, but there was a significant increase during October. This activity is shown to have originated mainly from the French nuclear tests on September 25 and October 5. (auth)

8227 DEUTERIUM CONTENT IN FRACTIONALLY COLLECTED RAINWATER. **Matsuo, Sadao; Friedman, Irving (Geological Survey, Denver, Colo.). J. Geophys. Res., 72: 6374-6 (Dec. 15, 1967).**

The deuterium and chloride contents of Tokyo rainwater serially collected from a variety of rain types are presented. The serial collection was made for every 1 mm of precipitation. The results of the analyses are tabulated. (M.H.R.)

Mineralogy and Exploration

8228 SURVEY OF THE RADIOACTIVITIES ON SHODO ISLAND, KAGAWA PREFECTURE. **Sato, Yoshiaki; Suzuki, Yasusuke (Geological Survey of Japan). Chishitsu Chosasho Geppo, 17: No. 2, 40-7(Feb. 1966). (In Japanese).**

The geology in Shodo Island is considered as favorable for the formation of sedimentary uranium ore deposits. Therefore, the radiation intensity distribution was surveyed; boring tests were also made since the regolith and detritus in this area were considered relatively thick. The surface investigation was made mainly on the boundaries between the granites of bed rocks and the volcanic rocks and detritus, distributed in the main and the eastern part of the island. Boring tests were made at two spots, viz. the concave of a rock bed, and near the bottom of the tertiary system containing mudstones of relatively high radioactivity; in neither case, abnormal radioactivity was detected. Near Nanpoo Dai in the eastern part of the island and in the Fukuda district, a radioactivity of 0.030 mr/hr was detected, which is rather high for the granites in this region. (NSA of Japan)

8229 ON THE RADIOACTIVE INTENSITY OF THE TERTIARY IN THE TSUGAWA AREA, NIIGATA PERFECTURE. Aoyagi, Nobuyoshi; Bojo, Toshiatsu (Geological Survey of Japan). Chishitsu Chosasho Geppo, 17: 451-8(Aug. 1966). (In Japanese).

The radioactive intensity of the Neogene sediments in the Tsugawa area of Japan was studied. The Tertiary Sediments, lying unconformably on Paleozoic formation (partly on granitic rocks) in this area, include three formations: the Tsugawa, Awase and Tokonami formations in ascending order. The Tsugawa formation is divided into two members: Kannonzawa conglomerate and Hirotani-tuff members. The former is the basal conglomerate of the Tertiary in this area. Hirotani-tuff member which accompanies with liparite, is the upper member of this formation. The radioactive anomalies are known at the basal parts of the Tsugawa formation in the adjacent area. But, in this field, no anomaly is recognized at the same horizon of the Tsugawa formation through this survey. The radioactive intensities of the upper two formations, the Awase and Tokonami are smaller than those of the Tsugawa formation in this area. (NSA of Japan)

8230 ON THE RADIOACTIVE INTENSITY OF THE URANIFEROUS BEDS OF NEOGENE IN MIKAWA-MURA AND ITS VICINITY, NIIGATA PREFECTURE, NORTHEASTERN JAPAN. Bojo, Toshiatsu; Aoyagi, Nobuyoshi (Geological Survey of Japan). Chishitsu Chosasho Geppo, 17: 459-71(Aug. 1966). (In Japanese).

In Yoshigasawa and Akatani areas, Mikawa-mura, Niigata prefecture, uraniferous beds have been discovered at the basal part of the Neogene Tertiary (Miocene). More extensive geologic and radiometric surveys of the Neogene sediments exposed within these districts and their adjacent areas were made in 1960 and 1962. The Neogene sediments in the area lying uncomformably on basement rocks (granites and Paleozoic formation) are divided into the Mikawa group, the Tsugawa formation, and the Awase formation in ascending order. It seems that the Tsugawa formation directly overlies the basal granites because of thinning out of the Mikawa group in Yoshigasawa and Akatani areas. Uranium occurs only at the lowest part of the Tsugawa formation, consisting of arkosic sandstone and conglomerate in the districts. The results of chemical analyses of rock specimens at the outcrops of the both areas show ~0.02 to 0.15% U_3O_8 in Yoshigasawa and ~0.06 to 0.14% U_3O_8 in Akatani respectively. It has been noticed that uranium has a tendency to be concentrated in coaly matter (thin coal seams, coal pieces, etc.) scattering in sandstone or conglomerate, but the extension of the uraniferous part is small. No remarkable radioactive anomalies were detected in the Neogene in the areas except in those recognized above. (NSA of Japan)

8231 SURVEY OF THE RADIOACTIVITIES IN KAMIUKENA-GUN, EHIME PREFECTURE. Kiyoshima, Nobuyuki (Geological Survey of Japan). Chishitsu Chosasho Geppo, 17: No. 2, 48-51 (Feb. 1966). (In Japanese).

Mineralization of the diabases in Kuman-cho, Mikawa-mura, and Odamachi, was studied, however, no remarkable mineralization was found. The radiation intensity of the diabases was lower than in other rocks. No abnormality was detected in the northern part of metamorphic rocks. Greenschists densely mixed with black phyllites in the Ryuya-mura area showed a maximum of treble abnormality. This is exposed for the 150 m from north to south along the open road on the left of Omogo River. The general strike of strata in the area is of an east-west direction, and the dip of bed changes remarkably, by foldings, to either north or south. Consequently, the true depth of strata at an abnormal radiation intensity is considered as about 50 m. No radioactivity was observed along to the extended direction of a strike of bed, and the radioactivity was localized, so that uranium ore deposits were not established. (NSA of Japan)

Oceanography

8232 (ORO-2411-8) NATURAL RADIOACTIVE ELEMENTS IN MARINE ENVIRONMENT. Final Report. Rona, Elizabeth (Miami Univ., Fla. Inst. of Marine Science). July 1967. Contract AT(40-1)-2411. 86p. Dep. CFSTI.

A resumé of research carried out at the Institute of Marine Sciences from 1960 to 1967 is presented. Before this project started, work on the problem of natural radioactive elements in marine environments was pursued in a somewhat haphazard fashion; it was not until the past decade that concentrated efforts were made to thoroughly study all aspects of the problem. Among the problems given particular emphasis were: chemical balance in the sea; inflow from rivers and deposition into sediments; mechanisms for the removal of the radioactive nuclides and stable trace elements; and determination of sedimentation rates of large areas. The study of the radium distribution in the oceans led to the conclusion that the sediments must be its principal source; emphasizing the importance of the sediment-water to oceanographic problems. One of the foremost interests was the dating of the Pleistocene epoch; theoretical considerations and critical discussions open the way for the successful dating of Caribbean cores to 200,000 years. The enclosed list of papers gives a more comprehensive understanding of the work carried out during this period. (auth)

8233 DEPOSITION OF URANIUM FROM THE OCEAN. Veeh, H. Herbert (Yale Univ., New Haven). Earth Planet. Sci. Lett., 3: 145-50(Nov. 1967).

Anaerobic sediments from the upper continental slope in the eastern Pacific, the Gulf of California, and a Norwegian Fjord have been analyzed for their total uranium content and $^{234}U/^{238}U$ ratios by alpha-spectrometry. The uranium concentrations range from 4.8 to 39 ppM and are thus significantly higher than the average uranium content of 3 ppM in deep sea clays, stream sediments and soils. The $^{234}U/^{238}U$ ratios approach the sea water value of 1.15 in samples with high uranium content. These results indicate that uranium is being removed from sea water in near shore areas under certain conditions. If such conditions prevail in only 0.4% of the total area covered by the ocean, an amount of uranium equal to that supplied by streams (assuming 0.04 μg/l) can be removed from the ocean, on the basis of measured accumulation rates in the Gulf of California, off southern California, and in other areas. The effect of Pleistocene sea level fluctuations as a controlling factor in determining the concentration of uranium in sea water is diminished by the occurrence of extensive areas of uranium deposition below 200 m and by the very long residence time of uranium in the ocean. (auth)

Seismology

8234 CHANGE IN DIRECTION OF THE FIRST MOTION OF THE UNDERGROUND NUCLEAR EXPLOSION DUE TO THE INFLUENCE OF SEISMIC WAVE ATTENUATION. Chang, Chih-chen. Bull. Inst. Geophys., Nat. Cent. Univ., No. 1, 85-8 (June 1967). (In Chinese).

Wave form analysis method is used to study the seismic wave form of first arrival at $\Delta = 300$ km of Logan explosion in 1958 at Nevada. The relation between spatial attenuation constant α and frequency of seismic wave f is $\alpha = Kf$. The value of K is calculated to be 0.00136 km^{-1}/cps under the condition that the first peak will attenuate to zero when the direction of first arrival is changed. Then, the second peak is calculated to be −4.53 mμ. It is the same order compared with that of record. The difference of absolute value may be caused by the difference of azimuth of the two stations $\Delta = 300$ km and $\Delta = 715$ km. Therefore, the conclusion that the change in direction of the first motion of the underground nuclear explosion is due to seismic wave attenuation is reasonable. (auth)

8235 TRAVEL TIMES FROM CENTRAL PACIFIC NUCLEAR EXPLOSIONS. Gogna, M. L. (Cambridge Univ., Eng.). Geophys. J., 13: 503-27(Nov. 1967).

Readings of P waves from widely recorded nuclear detonations in the Eniwetok and Bikini atolls in the Central Pacific have been published by Carder. Here the analysis is somewhat modified. Travel times are calculated up to 105°; the difference from the Jeffreys−Bullen times of 1940 is about −7.5 s at 10°, −3.5 s about 62°, and about −2.3 s from 95 to 105°. In the ranges 37 to 53° and 69 to 94° the differences are less than 2.0 s. (auth)

8236 ON THE TRAVEL TIMES OF P AS OBTAINED FROM THE NUCLEAR EXPLOSIONS BILBY AND SHOAL. Lehmann, I. Phys. Earth Planet. Interiors, 1: 14-23(Oct. 1967).

The travel times of the explosions Bilby and Shoal were studied. Bilby, which was fired on the Nevada test site, was by far the stronger of the two and its observations could be combined with those of other shots fired on the Nevada test site. It was found that there were differences in the travel times to the ESE, E, and NE of the site. There appeared to be a region of high velocity to the northeast. Some confirmation was obtained of the validity of the type of velocity distribution for the upper mantle considered by the author on previous occasions. (auth)

8237 DIGITAL EXPERIMENTS AT TWICE REAL-TIME SPEED ON THE CAPABILITIES OF THE YELLOWKNIFE SEISMIC ARRAY. Weichert, D. H.; Manchee, E. B.; Whitham, K. Geophys. J., 13: 277-95(July 1967).

A number of experimental seismic arrays have been constructed in the past few years. One such array, in the form of an asymmetric linear cross, was built at Yellowknife, NWT, by the United Kingdom Atomic Energy Authority in collaboration with the Canadian Department of Mines and Technical Surveys. Data from the 19 individual seismometers are recorded continuously on FM magnetic tape. The analogue tape data are multiplexed into a digital computer at twice the recording speed. The system allows the formation of 168 beams by the delay and sum method: different approaches to this problem and their implications for real time processing are discussed. The correlations between the phased sums of the two lines are calculated and events are detected automatically when the correlation rises above a trigger level for a preset length of time. For each event a selection of logarithmic correlations is output in analogue form, together with other pertinent information. The recorded data were analyzed in two modes: free search, in which the entire tape is searched by the computer; and selective search fine scan, in which events are selected visually from a helicorder record and subjected to a variety of search procedures. A 30-day free search experiment indicated that the 50% detection probability level is m4.1 ± 0.2. The location accuracy of the events detected during the 30-day experiment was of the order of 300 km in latitude and longitude, and fine scan experiments have shown that this accuracy may be improved. The signal/noise ratio improvement was close to the theoretical value. (auth) (UK)

8238 THE AMPLITUDE-DISTANCE CURVE FOR SHORT PERIOD TELESEISMIC P-WAVES. Carpenter, E. W.; Marshall, P. D.; Douglas, A. Geophys. J., 13: 61-70(July 1967).

An amplitude−distance curve was computed for short period P waves in the range $\Delta = 30° - 102°$ (and h = 0) using the amplitudes of explosion signals only. Effects of source asymmetry can thus be discounted and the problem of deciding what amplitude to measure is reduced because the maximum amplitude of explosion signals always occurs in the first few cycles. To increase the consistency of the measurements all the amplitudes were measured by the same person. Assuming the effect of distance is constant over a series of discrete intervals of distance, the amplitude−distance curve with its confidence limits was estimated by least squares, using data from 65 stations which recorded some or all of the explosions fired at six sites. The most striking features of the curve are: (1) a sharp maximum at about $\Delta = 35°$, (2) a minimum followed by a sharp increase at $\Delta = 75°$, and (3) a sharp minimum at $\Delta = 93°$. Over the remainder of its length the curve is similar to the Gutenberg and Richter curve. Station magnitude corrections were also estimated. (auth) (UK)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 8236 and 10136.

8239 (PNE-1001) GASBUGGY PRESHOT SUMMARY REPORT. Holzer, Fred (ed.) (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 1967. 20p. (UCRL-50345). Dep. CFSTI.

Two holes, GB-1 and GB-2, were drilled and completed naturally approximately 190 and 300 feet, respectively, from the explosive-emplacement hole, GB-E. The Pictured Cliffs sandstone, extending from 3916 to 4202 ft below the surface, has the following average properties: bulk density, 2.47 g/cm^3; compressional velocity, 13,500 ft/sec; porosity, 10%; and water saturation, 58% (4 to 5% water content by weight). The total gas in place is calculated to be 5.8 billion cubic feet (bcf) per 160 acres. When zones having water saturations of 60% or more are eliminated, a net volume of 4.7 bcf is obtained. While core permeabilities average 0.16 md, indicated in-situ permeabilities from buildup tests are between 0.01 and 0.02 md. In GB-1, about 50% of the gas came from a single fracture between 4000 and 4020 ft deep, and most of the remainder came from bedding planes in the Fruitland zone, between 3800 and 3882 ft. In GB-2, most of the gas came from a fracture near the top of the Pictured Cliffs. In view of the complex flow pattern, values of reservoir characteristics derived from flow tests must be considered apparent only. The 26-kt nuclear explosion at the base of the Pictured Cliffs is expected to create a chimney between 330 and 400 ft high with a radius of 78 ft. Fracturing should extend radially about 400 ft. No flooding of the chimney with water is expected. The chimney gas is expected to contain about 200 μC of tritium and 2 μC of ^{85}Kr per cubic foot of gas at normal temperatures and pressures. Rapid flaring of three chimney volumes might reduce these concentrations by a factor of ten. (auth)

8240 (PNE-1107(Pt.1)) CRATER STUDIES: CRATER MEASUREMENTS. Project PRE-GONDOLA I. Final Report. Harlan, Ronald W. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). May 1967. 93p. Dep. CFSTI.

Project Pre-Gondola I, a series of four 20-ton high explosive cratering detonations, was conducted by the U. S. Army Engineer Nuclear Cratering Group during October and November 1966 in order to determine the cratering characteristics of the Pre-Gondola project site located about 18 miles south of the town of Glasgow, Valley County, Montana. The essentially flat site medium consisted of uncemented, highly compacted, moderately jointed shale of the Late Cretaceous age, Bearpaw shale formation. The craters produced were both deeper and wider than those previously observed in either alluvium or basalt, but had flatter slopes. For single-charge craters in Bearpaw shale the optimum depth of burst for both apparent crater depth and radius is about 130 ft/kt$^{1/4}$. Pertinent data for the four events are given. (auth)

8241 (PNE-5011) THE FORMATION OF A CRATER AS OBSERVED IN A SERIES OF LABORATORY-SCALE CRATERING EXPERIMENTS. Bening, Robert G.; Kurtz, Maurice K. Jr. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Sept. 1967. 63p. Dep. CFSTI.

A qualitative description of the formation of a crater is developed on the basis of a series of laboratory-scale cratering experiments. The results of 41 one-pound, single-charge cratering detonations in a concrete sand placed under controlled conditions are summarized. The effect of depth of burst on crater dimensions is illustrated. The crater formed by a one-pound charge buried at a depth of burst of 2 feet is selected for analysis because the ratio depth of burst to depth of apparent crater is similar to that considered desirable for a prototype nuclear excavation. On the basis of these experiments and a series of gram-size, half-space cratering experiments conducted behind a Plexiglas plate, a description of the formation of a crater is hypothesized. Subsidence or slumping of the cavity walls during the formation of the crater is shown to play an important part in the formational process. The importance of this mechanism to the analysis of crater stability is discussed. (auth)

8242 (SC-RR-67-728) COMPARISON OF CRATERS FROM ROWS OF CHARGES DETONATED SIMULTANEOUSLY AND ONE AT A TIME. Vortman, L. J. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 44p. Dep. CFSTI.

Row charges made up of 64-pound spherical TNT charges were detonated in one instance simultaneously and in the other instance one-at-a-time in sequence for combinations of two spacings and three burial depths. Where the charges were detonated one at a time, the crater volume was reduced to nearly 50 percent of the volume for the comparable simultaneous detonation. There was not much difference for the combinations of burial depth and spacing tested. The craters from one-at-a-time detonations averaged about 35 percent larger for the greater spacing than for the smaller spacing versus only about 10 percent difference when the charges were fired simultaneously. (auth)

8243 (UCRL-50008-67-4) PLOWSHARE PROGRAM. Vol. II, No. 7, August 1-October 31, 1967. Rabb, David D. (comp.) (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 25p. Dep. CFSTI.

The task, Marvel Event, a nuclear explosion in an open tunnel at the Nevada Test Site was executed. The corresponding diagnostic experiments were performed. In the 67 ft penetration Piledriver chimney, samples were recovered for size analyses and radioactivity distribution studies. Plans are complete for Cabriolet, Buggy, and Sloop projects. Cabriolet-II explosive was recovered in preparation for Cabriolet III, a nuclear cratering experiment in hard, dry rock. (J.C.W.)

8244 (UCRL-50339) A DESIGN FOR PROJECT BRONCO, AN EXPERIMENT FOR NUCLEAR FRACTURING AND IN SITU RETORTING OF OIL SHALE. Lombard, David B.; Bray, Bruce G.; Sohns, Harold W.; Sterrett, Thomas S.; Brundage, Robert S.; Carpenter, Harry C. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 39p. Dep. CFSTI.

Project Bronco, a proposed 50-kiloton nuclear explosion experiment is described. The detonation will fragment and fracture a deep, thick oil shale deposit which will subsequently be retorted in place. Bronco will provide information related to: the technical and economic feasibility of the basic concept, a predictive capability for the physical effects of nuclear explosions, and the distribution of radioactivity and its behavior during retorting. Although the Bronco experimental design is based on a particular site in the Piceance Creek Basin, a preshot investigation will determine whether the nominated site will meet the technical and safety criteria for a first nuclear explosion in oil shale. Following site confirmation, holes will be drilled for fracture studies, for emplacing the explosive, and for shock wave measurements. The explosion is expected to produce a chimney 230 ft across and 520 ft high (measured up from the shot point), containing over one million tons of fragmented oil shale. Fractures may extend as far as 460 ft laterally beyond the chimney edge. Postshot drilling will reveal the size and shape of the chimney, the extent of fracturing, and the distribution of heat and radioactivity. Final design of the in situ retorting experiment will depend on results of the postshot exploration and on laboratory research currently underway. Tentatively, mixtures of air and recycle gas will be injected via drill holes to the chimney top. Drill holes to the chimney bottom will remove off-gas, oil mist, and liquid oil. During retorting, measurements will be made of temperatures in the chimney. Samples of gas and oil will be analyzed for physical characteristics, chemical composition, and radioactive content, if any. Additional data on retorting efficiency will be obtained in post-retorting drill holes. It is tentatively planned to follow the chimney retorting with an experimental outward-moving burn in a 45° sector of the fractured region outside the nuclear chimney. (auth)

8245 (UCRL-70762) NUCLEAR EXPLOSIVES: A POTENTIAL TOOL FOR THE DEVELOPMENT OF WATER RESOURCES. Korver, John A. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 8, 1967. Contract W-7405-eng-48. 11p. (CONF-671118-1). Dep. CFSTI.

From 3rd Annual American Water Resources Conference, San Francisco, Calif.

The use of nuclear explosions as a tool in the development of water resources is described. Properly sited nuclear craters can be used for ground water recharge, surface water storage, flood control, drainage, and recreation, nuclear chimneys can be used for waste disposal, and aquifier protection and diversion. The safety and economic feasibility of constructing nuclear craters and chimneys for water resources projects is discussed. (F.S.)

8246 DEEP REFLECTIONS FROM A NUCLEAR EXPLOSION IN A SALT DOME. Perret, William R. (Sandia Lab., Albuquerque, N. Mex.). J. Geophys. Res., 72: 6327-33(Dec. 15, 1967).

Data from four special gages in a boring, offset 166 meters from the Salmon nuclear explosion 828 meters deep in the Tatum salt dome, include five groups of reflection signals from below the source. The gages, accelerometers of high sensitivity to vertical motion, were at depths between 673 and 1190 meters. These data, interpreted by means of U. S. Geological Survey's crustal study data for the Tatum dome vicinity, yield depths to Louann-basement contact of 8.23 km, an unidentified interface near 13 km, the Conrad discontinuity at 17.1 km, an interface at 33 km, and the Mohorovicic discontinuity at 34.6 km. The last two reflections imply a transition zone at the crustal mantle contact. Uniqueness of these data lies in identical vertical paths from source to reflecting surface to detectors, a point source of high energy, and a vertical array of detectors of high vertical resolution. (auth)

Facilities and Equipment

Refer also to abstracts 8292, 8329, 8678, 8683, 8698, 8751, 8752, 8849, 9235, 9241, 9255, 9269, 10124, 10126–10128, 10140, and 10143–10145.

8247 (BAW–1280–47) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Quarterly Progress Report, April–June 1967. (Babcock and Wilcox Co., Barberton, Ohio. Boiler Div.). Oct. 1, 1967. Contract AT(11-1)-1280. 11p. Dep. CFSTI.

Progress on the fabrication of the Prototype Steam Generator is reported. The problems of the overheated tube, welding tubes to the tube sheet, and heat treatment of the shell are being evaluated. After these problems are resolved fabrication can continue. Thermocouples and strain gages for use during testing at SCTI were received. A mock up of a strain gage in a protective hut will be tested in sodium. The sodium to steam follow-on study is concentrating on setting design criteria and establishing cost trends. (auth)

8248 (BMI-X–10215) HEAT-RESISTANT CONCRETE FOR PRESTRESSED-CONCRETE-PRESSURE-VESSEL (PCPV) REACTORS. Quarterly Progress Report, July–September 1967. Lankard, David R.; Fondriest, F. Frederick; Snyder, M. Jack (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1967. Contract W-7405-eng-92. 12p. (EURAEC–1939). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Several concrete mix designs were evaluated and final selections were made of those to be used during the first phase of the program. The two mixes contain a highly siliceous sand and crushed siliceous gravel and a combination of a local concrete sand and crushed limestone. Both have a 28-day strength of approximately 6000 psi. Beam specimens of gravel and limestone concrete, 2.5 by 3 by 10 in., have been prepared for use in determining the flexural strength of concrete which has been exposed to temperatures up to 500°F. These specimens are currently going through a 28-day fog-room cure. After curing they will be heat treated at 175, 250, 375, and 500°F prior to breaking in center-point loading at 70, 175, 250, 375, and 500°F. Recent creep-strain measurements at room temperature on limestone and gravel cylinders indicated a satisfactory performance of the system. A series of gravel and limestone concrete cylinders 4 in. in dia by 24 in. long are being prepared for use in measurements of creep strain at normal and elevated temperatures. In addition to the investigations of the effect of heating on the load-bearing behavior of concrete, experiments are also directed at establishing the effects of exposure to elevated temperatures (up to 500°F) on the chemical makeup of the concrete. A study to measure the evaporable and nonevaporable water content of cement, mortar, and concrete heated for extended periods of time at 175, 250, 375, and 500°F is under way. A 6-ft-dia concrete sphere with a heat source cast into its geometrical center was prepared for the purpose of studying thermal-gradient-induced moisture movement in massive concrete. Heat and moisture losses occur only at the surface of the sphere. The temperature in the center of the sphere is being increased in small increments with the eventual objective of reaching 500°F in the center. Experiments to establish the effectiveness of additions of an artificial pozzolan in stabilizing the cement matrix of conventional concrete relative to the action of the simultaneous imposition of high pressure and the presence of superheated water are in progress. (J.C.W.)

8249 (CONF-670533–9) INERT GAS GLOVEBOX METALLOGRAPHIC FACILITY FOR RADIOACTIVE MATERIALS. Tucker, P. A. (Mound Lab., Miamisburg, Ohio). [Dec. 27, 1967]. Contract AT(33-1)–Gen-53. 21p. Dep. CFSTI.

From 21st AEC Metallographic Group Meeting, Upton, N. Y.

A double-faced, stainless steel glovebox, 21 ft long, was installed and successfully operated for metallographic studies of plutonium bearing materials. Continuously flowing dry nitrogen provides an inert atmosphere, and control of the pressure in the glovebox is completely automatic and self regulating. The glovebox is divided into eight double bays which contain a specimen mounting press, low speed grinders and polishers, vibratory polishers, ultrasonic cleaners, and facilities for chemical, electrolytic and cathodic etching. A B & L Dynazoom metallograph is mounted inside the glovebox with the trinocular eyepiece pod extending to the outside through a bellows seal. The design and operation of the facility are described. (auth)

8250 (DP-MS–67-71) PERFORMANCE OF CENTRIFUGAL MIXER–SETTLER IN THE REPROCESSING OF NUCLEAR FUEL. Webster, D. S.; Jennings, A. S.; Kishbaugh, A. A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.); Bethmann, H. K. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Oct. 16, 1967. Contract AT-(07-2)-1. 19p. (CONF-671103–4). Dep. CFSTI.

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York.

An eighteen-stage centrifugal mixer-settler, designed and developed at the Savannah River Laboratory, is now successfully separating plutonium and uranium from radioactive fission products. The design of the mixer-settler and tests that were conducted before installation of this equipment, and performance with radioactive solutions is described. Advantages of the centrifugal equipment over a pump-mix mixer-settler are associated principally with the smaller liquid volume holdup (1/50), and include reduced exposure of the solvent to radiolytic degradation, increased nuclear safety, easier flushing, and greater operating flexibility. The unit has a capacity of over 60 gpm total flow. In the new mixer-settler, pumping, mixing, separating, and decanting are all performed in a single device having a single rotating shaft. A particular feature of the new mixer-settler is the use of air pressure in a weir chamber to regulate remotely the emulsion position in the centrifuge. The centrifugal stages have high mass transfer efficiency; for example, an overall efficiency of ~95% is attained in stripping uranium from solvents. The unit has been performing well since startup, decontamination and losses are satisfactory, solvent picks up only 1/5 as much gamma activity as it did in the pump-mix mixer-settler, and shutdowns and startups are made rapidly without extensive flushing. (auth)

8251 (DRP/ML/FAR-R–168) PHENIX: CHOIX DE LA POSITION DES POMPES PRIMAIRES. (Phenix: Selection of Position of Primary Pumps). Baumier, J.; Gollion, H. J.; Michel, A. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires. Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 24, 1965. 5p. (In French). Dep. CFSTI.

An examination is made of the advantages and disadvantages resulting from the positioning of a primary pump downstream or upstream from an intermediate exchanger. (tr-auth)

8252 (EUR–3629) APPAREILLAGE DE MANUTENTION INTEGRE EN GRENIER (AMIG). (Handling Equipment Integrated in Loft). Aubert, M.; Fortin, G.; Rouge, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug. 1, 1967. 166p. (In French). Dep.

Information on all operations, studies and tests carried out as part of the research on the in-loft handling device is presented. A recapitulation of the basic philosophy underlying a system for in-loft unloading is included along with a description of what has been achieved such as loft, basic tests, control-rod studies, and other tests. Results of the tests carried out and the incidents observed during these tests are described. Findings concerning the use of each item of equipment tested, as well as new concepts deriving from these findings and from the experience acquired during operation of the mock-up are discussed. (auth)

8253 (K-1725) ENGINEERING DEVELOPMENT OF AN ABSORPTION PROCESS FOR THE CONCENTRATION AND COLLECTION OF KRYPTON AND XENON. Summary of Progress Through July 1, 1967. Merriman, J. R.; Pashley, J. H.; Smiley, S. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 19, 1967. Contract W-7405-eng-26. 51p. Dep. CFSTI.

Gas streams containing radioactive isotopes of the noble gases, krypton and xenon, must be safely processed to allow innocuous venting both in nuclear reactor accident situations and in future large-scale irradiated fuel reprocessing operations. One of the most direct methods for stripping krypton and xenon from contaminated air streams is selective absorption in a fluorocarbon solvent, such as refrigerant-12. A development program was recently initiated to provide engineering scale-up data for design of a plant using this technique. The scope of the work includes the design, construction, and operation of a pilot plant system; conceptual studies and equipment selection for a mobile gas absorption plant which could be transported to and installed at a reactor site following a release accident; and process optimization studies. Progress in each of these areas is summarized. The pilot plant design is essentially complete, with procurement and construction of equipment scheduled to begin shortly. Conceptual designs for two versions of a mobile system, both variations of a reference flow sheet based on a minus 94°F absorption step, have been completed, and detailed cost estimates were prepared. The optimization studies are well under way, with a mathematical model of the process currently being constructed. (auth)

8254 (NAA-SR-12547) HNPF SIX-ELEMENT IRRADIATED FUEL SHIPPING CASK. Berger, S.; Bonyhady, K.; Davis, B.; (and others) (Atomics International, Canoga Park, Calif.). Nov. 23, 1967. Contract AT(04-3)-701. 442p. Dep. CFSTI.

A general purpose cask design was prepared for shipment of 150 irradiated HNPF Core I fuel elements from the HNPF at Hallam, Nebraska, to the fuel reprocessing site, the Savannah River Plant at Aiken, South Carolina. Shipment will be by rail. The 40-ton cask, which will contain six doubly canistered HNPF fuel elements, provides an effective cavity of 18¼-in. dia by 197½ in. long, with 8½-in. lead equivalent shielding. For future use, following the HNPF shipment, the cask cavity length may approach 204 in. (fully shielded), depending upon the specific shipment requirements. The cask will be bottom-loaded at HNPF and top-unloaded at SRP, but may be either top- or bottom-loaded or unloaded in the future. The design is in accordance with the AEC Manual Chapter 0529 "Safety Standards for the Packaging of Radioactive and Fissile Materials," dated August 22, 1966. The design also meets the acceptance criteria of the SRP and is compatible with the requirements of the HNPF. (auth)

8255 (ORNL-4170, pp 158-9) DESALINATION. Franco-Ferreira, E. A. (Oak Ridge National Lab., Tenn.).

The costs of fabricating and using an unclad uranium metal fuel element in a desalination reactor plant are analyzed. Work on the design and construction of apparatus to test a method of producing this fuel element is also reported. (auth)

8256 (ORNL-TM-1793) PERFORMANCE AND CAVITATION CHARACTERISTICS OF TWO HELICAL ELECTROMAGNETIC-INDUCTION PUMPS OPERATING WITH POTASSIUM. Huntley, W. R.; Grindell, A. G. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 38p. Dep. CFSTI.

Two small, helical induction pumps of different design were operated with potassium at temperatures up to 1300°F to determine hydraulic, thermal, and cavitation-inception characteristics and to qualify them for use as boiler feed pumps in boiling-condensing potassium test facilities. The first pump tested had a helical two-pass reentrant pump cell fabricated of Nb-1% Zr alloy. The second pump had a single-pass helical pump cell fabricated of stainless steel. The data indicated that the pumps were suitable for their respective boiler feed functions. However, the data for the refractory-metal pump revealed a peculiar hydraulic response to a change in either applied voltage or system flow resistance. An instantaneous hydraulic response would first occur, followed by a slower thermal equilibration. The time required to achieve thermal equilibrium was relatively very long at low flow rates. For both pumps, two different values of net positive suction head (NPSH) were required to suppress cavitation at nearly identical pump operating conditions. The smaller value was associated with reducing NPSH by decreasing the amount of subcooling at the pump inlet in the absence of argon cover gas in the system; the larger value was associated with reducing NPSH by decreasing the pressure of argon cover gas on the potassium liquid surface in the loop expansion tank. In the absence of argon cover gas, the potassium liquid at the pump inlet would not cavitate at negative values of the suction head; this indicated ability to sustain tensile forces. (auth)

8257 (ORNL-TM-2002) GAS ABSORPTION THEORY APPLIED TO CONTAINMENT SPRAYS. Parsly, L. F. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 34p. Dep. CFSTI.

A brief review is presented of the pertinent literature on the gas absorption theory as applied to containment sprays. It is demonstrated that equilibrium and mass-transfer rate equations may be used to predict spray performance for removal of fission product compounds from building atmospheres. A simplified procedure for calculating the effect of condensation on the spray performance is presented; this gives an overly conservative answer. (auth)

8258 (ORNL-TM-2064) STRUCTURAL ANALYSIS OF THE BROOKHAVEN NATIONAL LABORATORY SHIPBOARD IRRADIATOR. Evans, J. H. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 82p. Dep. CFSTI.

The methods of evaluating the structural integrity of a container in which radioactive material is shipped to show compliance with the governing regulations are illustrated in this report of the structural analysis performed on the Brookhaven National Laboratory Shipboard Irradiator. Testing methods, calculatory procedures, and operating experience were applied in the analysis of the cask with respect to the regulations covering the general standards for packaging, the structural requirements, the normal conditions of transport, and the hypothetical accident conditions. Structural modifications were proposed to eliminate deficiencies in the existing cask, and this analysis demonstrated that with the proposed cask lid, lifting devices, and crash frame, the irradiator complies with all the applicable regulations. (auth)

8259 (TID-4100(Suppl.42)) SUPPLEMENTAL INSERT SHEETS FOR ENGINEERING MATERIALS LIST. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Dec. 1967. 65p. DTIE Free.

Twenty-one packages of engineering materials on accelerator equipment; cameras; laboratory equipment including an extensometer; ruby laser head; viscometer; process plants, including a fluorination plant and equipment; radiation detection instruments; and adjustable and bakeable valves are announced in this supplement for inclusion in TID-4100. (F.S.)

8260 REPORT ON THE FISSION PRODUCT CONVERSION AND ENCAPSULATION FACILITY. Weissmann, T. S. (Isochem Inc., Richland, Wash.). pp 187-210 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

The Fission Product Conversion and Encapsulation Facility of Isochem, Inc., at Richland, Washington, is described in detail including the plant layout, process design features, heating and air conditioning equipment, instrumentation, electrical features, and process flow diagrams. The properties and uses of fission products, especially ^{144}Ce, ^{137}Cs, ^{147}Pm, and ^{90}Sr, are described and tabulated. The quantities of each of these four radioisotopes produced from the wastes of a plutonium production plant are given. (L.C.L.)

8261 CANADIAN INDUSTRIAL IRRADIATOR PROGRAM. Hetherington, C. H. (Atomic Energy of Canada Ltd., Ottawa). pp 213-23 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

In 1949 a Canadian group of scientists was formed to develop commercial uses for the radioisotopes that could be produced in the NRX Reactor at Chalk River. The history and progress of this work are reviewed with particular emphasis on the uses of ^{60}Co in medicine for therapy and equipment sterilization and in industry for food preservation. (L.C.L.)

8262 MEASUREMENTS OF MELTING CONDITIONS IN CUPOLA BY MEANS OF γ-RAY PENETRATION. SPECIALLY ON THE EFFECTS OF BLAST VOLUME. Kayama, Nobutaro; Nakae, Hideo (Waseda Univ., Tokyo). Waseda Daigaku Rikogaku Kenkyusho Hokoku No. 36, 119-29(Sept. 1966). (In Japanese).

A study of the behavior of the charged materials and the melting condition in cupolas by means of γ-rays penetrating through the belly of cupolas are described. Effects of the variation in blast volume on the cupola melting condition have been principally studied. A water-cooled cupola with 400 mm in internal dia and 2400 mm in effective height was used in these experiments. γ-rays penetrated 570 mm above the tuyere level and just on the upper limit of the bed coke, where the metal was about to begin melting, and the continuous records of intensity of the penetrated γ-rays were analyzed. Also the experiments with γ-ray penetration through the bed coke zone were performed to check the condition in this zone. The γ-ray penetration indicated the behavior of the charged material in cupola fairly accurately. More than 10 experiments were performed and the following results were obtained: (1) With a little excess of blast volume, small voids occur in the position where the metals begin to melt and the melting condition is confused due to the fact that the falling of the solid materials can not follow the increasing rate of coke consumption and of iron melting. (2) There is a correlation between the continuous recording curves of tapping temperature and of γ-ray penetration intensity, and this can be a measure indicating the melting condition in cupola. (3) In the bed coke zone there are always small voids due to the coke consumption so that the coke is not filled completely. (auth)

8263 THE PURIFICATION PLANT FOR CONCENTRATES AT THE CENTRO NACIONAL DE ENERGIA NUCLEAR "JUAN

VIGON." Regife, J. M.; Ramos, L.; Berberana, M. Rev. Met. (Madrid), 3: 58-66(Jan.–Feb. 1967). (In Spanish).

Purification of uranium concentrates up to nuclear purity has been carried out in Spain since the beginning of the 1950's. By 1954, an ethyl ether extraction pilot-plant was already available and a small production unit was later set up using TBP and columns of 10 ton U/year capacity. During 1962 the development, design and assembly of a plant with external box-type mixers-settlers of approximately 300-ton-U/year capacity was undertaken. This plant started operating in 1963. A brief description of the plant, together with the experiences obtained during its operation, are given. 21 ref. (Rev. Met. Lit.)

8264 BEARING AND SEAL DESIGN IN NUCLEAR POWER MACHINERY. The Symposium on Lubrication in Nuclear Applications, Miami Beach, Fla., June 5–7, 1967. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967. 536p. $19.00. (CONF-670601). DTIE.

Twenty-eight papers on bearing and seal design and lubrication in nuclear power machinery are presented. Separate abstracts were prepared for 27. One paper appeared in NSA previously as 21: 26127. (L.C.L.)

For abstracts of individual papers see: 8265–8280, 8299, 8751–8753, 8789, 8826, 8827, and 8849–8852.

8265 REACTOR MACHINERY. Grossman, Nicholas (Atomic Energy Commission, Washington, D. C.). pp vii-xv of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

An historical review of the development of nuclear power generation is presented, and some problems of machinery lubrication that are peculiar to nuclear power plants and the nuclear environment are described. (L.C.L.)

8266 PROCESS FLUID LUBRICATED TURBOMACHINERY IN NUCLEAR APPLICATIONS. Sternlicht, B.; Schwarz, H.; Luchter, S. (Mechanical Tech. Inc., Latham, N. Y.). pp 1-20 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5-7, 1967. See CONF-670601.

Brayton cycle power generation systems and motors, steam and gas turbine driven circulators utilizing "process fluid lubrication" are discussed. Some of the advantages of "process fluid lubricated" turbomachinery in nuclear applications are presented. Recent developments in this field are summarized and some of the required investigations pointed out. (auth)

8267 DESIGN ASPECTS OF MOTOR-DRIVEN GAS-BEARING COMPRESSORS. Schwarz, Hans (Mechanical Tech. Inc., Latham, N. Y.). pp 21-32 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

Engineering specifications are presented on the broad aspects of design and analysis of motor driven compressors using self-acting process-fluid lubricated bearings. These broad aspects include general specifications, the aerodynamic and thermodynamic behavior of the compressor fluid, motor requirements, bearing design, materials, instrumentation for monitoring the performance of the system, and costs. (L.C.L.)

8268 STUDIES OF LOW AND HIGH TEMPERATURE CAGE MATERIALS. Zaretsky, E. V.; Scibbe, H. W.; Brewe, D. E. (Lewis Research Center, Cleveland). pp 33-51 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

Seven self-lubricating retainer materials were evaluated in 40-millimeter-bore ball bearings operating in a 60°R hydrogen gas at 20,000 rpm and with a 200 pound thrust load. The relative wear of six high-temperature bearing cage materials was also determined at 500 and 700°F in a nitrogen-blanketed cage compatibility tester. When used as cages, glass-fiber-filled and bronze-filled polytetrafluoroethylene (PTFE) materials provided transfer films on the bearing inner-races for test durations exceeding 10 hours without evidence of race wear at the cryogenic temperature. Minimum cage wear was obtained at cryogenic temperature with the laminated glass cloth PTFE and the filled PTFE materials. At the elevated temperatures, S-Monel and AISI M-1 materials gave least wear. For these materials wear decreased with increasing material hardness. (auth)

8269 MECHANICAL ELEMENT DESIGN FOR HIGH TEMPERATURE SODIUM ENVIRONMENT. Baumgartner, A. J. (Atomics International, Canoga Park, Calif.). pp 70-92 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

Problems associated with the design and selection of materials for mechanisms in a sodium environment are presented. Promising materials are recommended, and a design philosophy for certain mechanical elements is described. These design problems are particularly important due to the rapid development of sodium cooled fast breeder reactor for central power plants. Included among the empirical data are tables of the heat transfer characteristics of liquid metals, corrosion rates and friction coefficients for materials in a high temperature sodium environment, nuclear activity levels of materials, results of bearing wear tests, and the nature and effects of sodium oxide deposits. General design rules for mechanisms in a sodium environment are suggested. (L.C.L.)

8270 DAMAGE TO BEARING MATERIALS IN CAVITATING MERCURY. Benjamin, W. D.; Vargo, E. J. (Thompson Ramo Wooldridge Inc., Cleveland). pp 93-109 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

The cavitation erosion resistance of several materials were determined by means of rapidly rotating test specimens in mercury. The materials represent metals or alloys which could be considered for use as journal bearings in the turboalternator of a 4 kW(e) mercury Rankine power system. The results of the test were evaluated by weight loss, depth of erosion, and electron microscopic examination of a replica of the damaged surface. Erosion damage was correlated with hardness for both ductile materials and tool steels. Variations of damage with the carbon content and volume fraction of carbides in several tool steels were found. Damage to the ductile single phase alloys was general, whereas the two-phase materials were damaged by general erosion of the matrix and by cleavage fracture and/or loss of the brittle second phase (carbides). (auth)

8271 CAVITATION-EROSION EXPERIENCE IN LIQUID-MERCURY LUBRICATED JOURNAL BEARINGS. Decker, Otto (Franklin Inst. Research Labs., Philadelphia); Winder, Charles R. pp 110-33 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

Cavitation-erosion experience in liquid mercury lubricated fluid film bearings is reviewed. A hypothesis is presented of how cavitation-erosion damage occurs in these bearings. The causes for the damage, such as the nature of the lubricant, the operating conditions, and the types of bearings selected, are discussed. Typical bearing damage patterns are presented which verify the cavitation-erosion hypothesis. Cavitation-erosion in mercury Rankine turbo-alternators is virtually eliminated by application of corrective action based on the developed hypothesis. (auth)

8272 TECHNIQUE FOR EVALUATING CAVITATION DAMAGE. Benjamin, W. D. pp 134-9 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

The application of electron microscope fractographic techniques to the evaluation of cavitation damage is presented, with examples of electron micrographs of the surfaces of specimens from a laboratory study of cavitation damage. Details of replication techniques are given along with a discussion of the interpretation of the electron micrographs. Different modes of damage were found for ductile single phase alloys, two phase alloys consisting of brittle second phase particles in a ductile matrix, and hardened tool steels consisting of carbides in a martensite matrix. (auth)

8273 WATER-LUBRICATED THRUST BEARINGS FOR A HELIUM CIRCULATOR. Shapiro, W. (Franklin Inst. Research Labs., Philadelphia). pp 140-67 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

A design study of water lubricated thrust bearings for a helium circulator used in a gas-cooled reactor nuclear power plant is discussed. The configurations investigated included a hydrodynamic and a hybrid bearing. The analytical treatment, configuration concept, and predicted performance are presented for each of the bearings. The matrix-column numerical method for solving Reynolds' equation in polar coordinates and for handling Rayleigh Steps is developed. Qualitative and quantitative comparisons accentuate the advantages and disadvantages of each bearing type and provide the basis for a recommended selection. (auth)

8274 EXPERIMENTAL INVESTIGATION OF WATER LUBRICATED BEARINGS IN THE TURBULENT REGIME. Ketola, H. N.; McHugh, J. D. (General Electric Co., Schenectady, N. Y.). pp 168-86 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

A crowned tilting pad thrust bearing and a full 360° cylindrical journal bearing were operated over a range of loads, speeds and water flow rates. Thrust bearing power loss was measured for a range of speeds from 3,600 to 10,000 rpm and loads from 750 to 3,000 lbs (maximum unit load of 70 psi). Power loss results are presented in the form of a turbulent/laminar loss ratio (J_T) vs. Reynolds number. Power loss is shown to be considerably less than predicted from previously available performance data. Measurements of film thickness confirmed full film lubrication and provided insight into performance of crowned tilting pad bearing under turbulent conditions. The journal bearing was tested from 3,600 to 10,000 rpm and loads up to 1250 lbs. (maximum unit load of 110 psi). Instabilities encountered under conditions of light loading and high speed were suppressed by increasing load. Journal bearing load capacity increased in the turbulent regime in accordance with theoretical predictions. (auth)

8275 LIMITS OF EFFECTIVENESS OF THE SCREW SEAL IN LAMINAR FLOW. McHugh, J. D. (General Electric Co., Schenectady, N. Y.). pp 187-202 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

The screw seal is a non-contacting device for sealing rotating shafts by the anti-leakage, pumping action of helical grooves. In laminar flow, it is shown that such grooves are effective only up to a certain limiting value of seal duty coefficient, i.e., a dimensionless combination of seal operating conditions, length and clearance. At values in excess of the limiting seal duty coefficient, the screw seal will permit more leakage than a plain sleeve seal of comparable dimensions. (auth)

8276 LEAKAGE BETWEEN SURFACES IN ELASTIC CONTACT. Rowe, M. D.; Mitchell, L. A. (Central Electricity Generating Board, Berkeley, Eng.). pp 203-18 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

Many investigators have considered plastic deformation of seal surfaces; in this analysis the asperities are represented by caps of spheres and their deformation assumed to be entirely elastic. From the relation between contact pressure and deformation, a leakage flow expression is derived for various values of surface roughness. On a logarithmic plot of leakage flow against apparent contact pressure, a slope of –1 represents a condition of maximum leakage flow for a fixed contact load. Hence, from the leakage characteristics obtained, a seal design optimization procedure may be established, which reduces the leakage flow. The analysis also permits the introduction of a leakage flow term representing the effect of surface waviness, upon which the micro-roughness is superimposed. (auth)

8277 SUPER-LAMINAR FLOW IN BEARINGS AND SEALS. Pan, C. H. T.; Vohr, J. H. pp 219-50 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

Possible fluid-dynamic processes in thin films of low kinematic viscosity fluids are discussed and parameters governing the flow regimes are identified. Recent analytical and experimental studies on related subjects are reviewed. Analysis based on the "wall law" of turbulent shear flow has accounted for most experimental data on super laminar thin film flows. The phenomenon of secondary vortices is important only for relatively thick films (according to lubrication practice). Mean inertia effects are the major unresolved items in the analysis of bearings and seals lubricated with low kinematic viscosity fluids. (auth)

8278 HYBRID GAS BEARINGS FOR A GRAPHITE HELICAL SCREW EXPANSION ENGINE. Donaldson, R. R. (Univ. of California, Berkeley). pp 336-53 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

Preliminary tests have indicated the feasibility of an all-graphite helical screw expansion engine for operation at temperatures of 4000 to 5000°R. Substantial lateral and thrust bearing loads, due to pressure unbalance, are inherent in this design. An analytical investigation is presented of an unusual gas journal bearing design in which the pressure differential within the machine is used to provide an asymmetric hydrostatic load capacity, with additional capacity being obtained hydrodynamically. Bearing performance calculations based on a finite-difference computer solution of the compressible Reynolds equation, are presented and are shown to compare favorably with design requirements. (auth)

8279 DESIGN OF A PROCESS FLUID TURBULENT FILM SHROUDED STEP THRUST BEARING FOR CIRCULATORS FOR HIGH TEMPERATURE HELIUM COOLED REACTORS. Wachmann, C. (Mechanical Tech. Inc., Latham, N. Y.); Wilcock, Donald F.; Yampolsky, J. pp 354-70 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

A design method for the turbulent shrouded step thrust bearing is presented. This type of bearing, a finite width step bearing with side lands to limit leakage, offers the significant advantages of large tolerance to wear, no moving parts and the capacity to be used as both a hydrostatic and hydrodynamic bearing. In the application described here the bearing operates with a turbulent water film (one of the two process fluids) in a steam driven helium circulator, in which high reliability and an unattended long life are mandatory. The use of water as the lubricant simplifies the design of the seals and of the lubricant system. (auth)

8280 NON-CONTACTING DYNAMIC SEALS FOR SPACE POWER ALTERNATORS. McGrew, J. M.; Orsino, A. J. (General Electric Co., Schenectady, N. Y.). pp 398-420 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

The design and testing of three different non-contacting seal systems is described. Pressure capability, power loss factors and seal leakage data are given for all three systems. Over 200 hours of test experience on three types of noncontacting dynamic seals have shown leakage rates comparable to mechanical face seals, and demonstrated the possibility of extremely long seal life because of the absence of rubbing parts. (auth)

8281 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR CORRUGATING SETS OF FINS. (to Commissariat a l'Energie Atomique). British Patent 1,095,089. Dec. 13, 1967. Priority date Sept. 17, 1965, France.

An apparatus for corrugating previously machined sets of fins on sectors of tubular elements, particularily sheaths for nuclear fuel elements, is described. The corrugating of these fins improves the heat exchange and minimizes deformation of the fins during thermal cycles or during lamination. (W.H.K.)

8282 FLUID FLOW MEASUREMENT. Bentley, Peter Graham; Burton, Eric John; Dawson, David Garnet (to United Kingdom Atomic Energy Authority). British Patent 1,095,476. Dec. 20, 1967. Filed Oct. 17, 1963.

A method is described for measuring the mean velocity of a fluid in a flow path, in which random temperature fluctuations continuously occur. Fluid flow measurements are carried out by comparing the response of two thermocouples immersed in a fluid such as the water coolant of a water-cooled reactor, to temperature fluctuations inherent in the fluid, or by using one transducer and comparing responses at differing preselected frequencies. (F.S.)

8283 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Goodwin, William Edward (to United Kingdom Atomic Energy Authority). British Patent 1,095,545. Dec. 20, 1967. Filed Sept. 2, 1964.

A nuclear reactor fuel element assembly consisting of a cluster of spaced, end supported fuel rods and at least one transverse bracing grid for the fuel rod is described. The grid consists of an undulating strip material attached to a bounding rim. The strip material has two superimposed spaced layers and is arranged so that loops of one layer cooperate with loops of the other layer defining cells containing fuel rods. (F.S.)

8284 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Smith, Thomas Gavin; Lindsay, Graham Eades (to United Kingdom Atomic Energy Authority). British Patent 1,096,304. Dec. 29, 1967. Filed Aug. 28, 1964.

Improvements in reactor fuel elements for liquid cooled, moderated, and reflected reactors to provide increases in thermal flux for neutron beam experiments are described. The fuel element has an outer tubular casing, a number of inwardly directed cantilever members secured to the inner surface of the casing, and a series of spaced concentric fuel-containing tubes supported lengthwise between the cantilever members. The encasing tube has 60 coolant holes. (F.S.)

8285 NUCLEAR REACTOR FUEL ELEMENTS. Robertson, James Martin (to United Kingdom Atomic Energy Authority). British Patent 1,095,652. Dec. 20, 1967. Filed Mar. 20, 1964.

A method for fabricating fuel elements with helical seams is described. A strip which forms the helical seam is a protectively clad sheet of nuclear fuel material wound to bring adjacent edges of the strip into abutting edge-to-edge relationship. The adjacent edges of the strip are joined together to form a tube with a helical seam. (F.S.)

8286 IMPROVEMENTS IN OR RELATING TO MASTER SLAVE MANIPULATORS. Le Guennec, Rene (to Commissariat a l'Energie Atomique). British Patent 1,095,691. Dec. 20, 1967. Priority date May 5, 1964, France.

Improvements are described for an improved articulation mechanical master slave manipulator. A locking method is provided so the slave arm may be locked in a chosen angular or perpendicular position. The response of the manipulator is improved also by allowing passage (without dismounting) of the complete slave assembly through a sealed passage through the protective wall. (F.S.)

8287 APPARATUS FOR ELECTRONIC BOMBARDMENT OF A TARGET. Meulemans, Marcel; Henuset, Maurice; Groeseneken, Paul (to European Atomic Energy Community). British Patent 1,096,261. Dec. 20, 1967. Priority date Feb. 14, 1964, Netherlands.

An electron irradiation apparatus is described. Two or more moveable electron guns are positioned around a moveable target for improved uniformity of irradiation. (W.H.K.)

8288 BUILDING STRUCTURES. (to United Kingdom Atomic Energy Authority). British Patent 1,096,363. Dec. 29, 1967. Priority date Sept. 28, 1964, Canada.

A seal for closing a wall opening in a pressure-containing enclosure is described. A rapid pressure reduction in the enclosure is effected when the differential across the structure exceeds a predetermined value. The seal consists of a framework which defines a number of apertures sealed by displaceable panels which are held closed by means of a pressure differential sealing method located between the panels and the framework. The seal is adapted for use in a nuclear reactor buildup in which a fueling machine enclosure is operated with a CO_2 atmosphere kept at a pressure slightly in excess of atmospheric. The remainder of the building operates at normal pressure and the fueling machine enclosure is sealed off by a wall which has an opening normally closed by the building structure. (F.S.)

8289 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Smith, Thomas Gavin; Lindsay, Graham Eades (to United Kingdom Atomic Energy Authority). British Patent 1,096,306. Dec. 29, 1967. Filed Aug. 28, 1964.

Methods are described for cooling fuel elements in reactors, particularly those in which a liquid is used as moderator, coolant, and reflector. The fuel element consists of a tubular casing, and a number of fuel-containing tubes held in a concentric spaced relationship within the casing to form annular coolant passageways. The casing which extends beyond the ends of fuel tubes forms a common inlet duct and a common outlet duct. Apertures in the wall casing form the outlet, and a frusto-conical shaped diffusion member in the outlet duct provides a number of apertures on the side wall. (F.S.)

8290 NUCLEAR REACTOR FUEL ELEMENTS. Beswick, William Frederick; Orrell, Brendan (to United Kingdom Atomic Energy Authority). British Patent 1,096,276. Dec. 20, 1967. Filed Mar. 18, 1964.

A reactor fuel element consisting of an assembly of plate fuel and support members is described. Each plate fuel member is an elongated plate of fissile material protectively roll clad in a nonfissile material. The plate fuel elements are secured to the support members and one another using an electron beam technique so that the electron beam penetrates the support members and plate fuel members to form welded joints. (F.S.)

8291 IMPROVEMENTS IN OR RELATING TO INCINERATORS. Clare, George William; Yeats, Francis William (to United Kingdom Atomic Energy Authority). British Patent 1,096,072. Dec. 20, 1967. Filed Feb. 27, 1964.

An improved incinerator is described which is suitable for the destruction of toxic materials such as radioactive waste. Waste is reduced in bulk and the ash is disposed of by burial. The incinerator consists of a refractory chamber, combustion method and an airtight enclosure with air locks at the entry ports. The chamber is maintained at negative pressure. Gases follow a tortuous path through a brick labyrinth before entering the outlet duct. The incinerator usually includes an after burner and settlement chamber. The gases are cooled and treated before being discharged to the atmosphere. (F.S.)

8292 CLOSURE FOR CONTAINERS. (to Waagner-Biro Aktiengesellschaft). British Patent 1,095,516. Dec. 20, 1967. Priority date June 17, 1964, Austria.

A closure is described for containers used for dangerous materials such as radioactive substances or poisonous gases. The closure consists of a screw spindle and traveling nut mechanism which includes draw hooks for engagement with the container. The draw hooks are retained on the cover in a manner such that travel of the nut on the spindle in one direction causes the cover and draw hooks to clamp the container between them. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 8247, 8282, 9149, 10022, 10137, and 10161.

8293 (ANL-7337) EXPULSION OF LIQUID FROM A RAPIDLY HEATED CHANNEL. Singer, Ralph M. (Argonne National Lab., Ill.). May 1967. Contract W-31-109-eng-38. 66p. Dep. CFSTI.

To determine the dynamic behavior of a partially confined liquid in contact with a rapidly heated surface, experiments were conducted using water, methanol, ethylene bromide, and acetone. The inner wall of an annulus was rapidly heated by a rectangular power pulse; the pressure, temperature, and motion of the fluid in the annulus were measured. The wall was heated at rates up to about 1.4×10^4°C/sec, the liquids were subcooled from 0 to 110°C, the liquid head varied from 0 to 1.5 m above the heated section, the annular spacing was either 1.27 or 3.18 mm, the initial liquid velocity varied from 0 to 9 m/sec, and the initial system pressure was always 1 atm. Transient pressures up to about 16 atm and expulsion velocities up to about 16 m/sec were measured. Only slightly subcooled liquids could be expelled, although the largest pressures were generated when the liquid was highly subcooled. The results of over 400 experiments are summarized. (auth)

8294 (BNWL-371(Pt.2)) CROSSFLOW MIXING BETWEEN PARALLEL FLOW CHANNELS DURING BOILING. PART II. MEASUREMENT OF FLOW AND ENTHALPY IN TWO PARALLEL CHANNELS. Rowe, D. S.; Angle, C. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 63p. Dep. CFSTI.

Laboratory experiments were conducted to determine the amount of mixing that occurs between two interconnected flow channels during boiling. The experiments were performed with water at 900 psia flowing through electrically heated test sections that simulated two adjacent channels typical of a 19-rod bundle. The results of the experiments showed that mixing during nonboiling conditions was nearly independent of rod spacing and could be correlated as a function of Reynolds Number. The results also showed that mixing during boiling is not necessarily higher than during nonboiling conditions. Mixing during boiling was found to be dependent upon rod spacing, flow rate, and, possibly, steam quality. The results also agreed well with predictions of the computer program COBRA which was developed in the first part of this study to compute flow, enthalpy and pressure in rod bundle subchannels. (auth)

8295 (BNWL-552) FORTRAN-IV COMPUTER PROGRAM FOR CALCULATING TRANSIENT HEAT TRANSFER COEFFICIENTS FROM WALL TEMPERATURES. Owzarski, P. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1967. Contract AT(45-1)-1830. 32p. Dep. CFSTI.

The computer program XINGU was developed to analyze transient wall and steam temperatures during a transient experiment. By calculating the temperature-time history in the containing walls, transient heat transfer coefficients are estimated and total heat exchange per unit area is calculated. The capabilities, use, and methods used in the program are described. The program was written in FORTRAN-IV for use on UNIVAC-1108. (F.S.)

8296 (TRG-Report-1455) THERMAL INSULATION IN RELATION TO CRYOGENICS. Probert, S. D. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Feb. 28, 1967. 106p. Dep. CFSTI. UK 15s. 0d.

The thermal properties and applications of liquid refrigerants and recommended codes of practice are described. Modern cryogenic container designs are discussed. Methods of inhibiting heat leaks across the vacuum space by radiation, conduction, and convection; vapor collection above the boiling refrigerant; thermal conduction through the neck; and through mechanically strong supports other than the neck, are considered. Physical processes governing heat transfer through fluids and solids are outlined. It was found that the thermal insulation for multi-layer stacks of stainless steel in compression compares very favorably with those of solid insulators. Microthermoelectric heat pumps and electromagnetic levitators are evaluated as means of inhibiting heat leaks via mechanically strong supports. (F.S.)

8297 (AEC-tr-6928) DISCHARGE OF SATURATED WATER FROM LONG DUCTS. Ogasawara, Eio. Translated from Nippon Kikai Gakkai Rombunshu, 33: 121-4(1967). 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Theoretical studies of thermo- and fluid dynamic critical two-phase flow were tested experimentally by studying the discharge of water from long tubes. From the results of the study it was concluded that: the relationship between slip ratio and pressure predicted by theory was verified; the relationship between critical quantities was confirmed for critical pressures up to 40 atm; the effect of tube diameter is negligible up to 50.5 mm; critical pressure ratio increases with tube length for L/D below 10 and decreases slightly with length for L/D above 20; and two-phase critical flow can be treated as a primary elementary flow. (auth)

8298 (BNL-tr-167) EXPERIMENTAL STUDY OF HEAT TRANSFER FROM HORIZONTAL FLAT SURFACE TO SODIUM UNDER FREE CONVECTION. Kudryavtsev, A. P.; Ovechkin, D. M.; Sorokin, D. N.; Subbotin, V. I.; Tsyganok, A. A. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from pp 131-6 of Zhidkie Metally, Atomizdat, Moscow, 1967. 10p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Heat transfer experiments were conducted with a flat, horizontal stainless steel surface heated by electron bombardment. The level of sodium above the surface was 150 mm. The temperature field of the sodium was measured using a movable thermocouple. Sodium temperature profiles are given. Equations are given for calculation of heat transfer. (M.C.G.)

8299 ANALYTICAL APPROACHES TO THE PROBLEM OF TURBULENT FILM LUBRICATION. Burton, R. A. (Southwest Research Inst., San Antonio). pp 442-61 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5-7, 1967. See CONF-670601.

Computational techniques suggested by the past work on the turbulent lubricant film are compared as to their ability to predict pressure flow data from wall-law profile data. Reasonable agreement among several approaches is indicated by trial numerical results. To provide information or orthogonal pressure flows and Couette flow, new experimental data are reported and discussed relative to mixing length and eddy viscosity variation. (auth)

Isotope Technology

Refer also to abstracts 8214, 8260, 8261, 8427, 8689, and 8707.

8300 (AERE-R-5523) FURTHER INVESTIGATION OF SILT MOVEMENT IN THE EBB CHANNEL, FIRTH OF FORTH, USING RADIOACTIVE TRACERS, 1966. Smith, D. B.; Parsons, T. V.; Wearn, P. L. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). July 1967. 12p. Dep. CFSTI. UK 5s. 0d.

A previous investigation into spoil movement in the Ebb Channel spoil ground, Firth of Forth, showed that short-term movement was principally downstream on to an area of mud banks. The present investigation used ^{46}Sc as the radioactive tracer, and this enabled spoil movement to be followed for nearly 4 months. The principal movement was downstream along the line of the Ebb Channel, which confirms the results of the previous investigation. Deposition at slack low water only produced a very limited upstream movement. After one month, traces of material reached the southern edge of the main channel. Hydrographic surveys will be undertaken to investigate the question of long-term spoil consolidation. (auth)

8301 (ALO-3634-7) RESEARCH AND DEVELOPMENT OF VACUUM FOIL-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. Quarterly Progress Report, September 1967-November 1967. Dunlay, J. B.; Fronduto, J.; Peredetto, E.; Paquin, M. L.; Poirier, V. L. (Thermo Electron Corp., Waltham, Mass.). Dec. 29, 1967. Contract AT(30-1)-3634. 103p. (TE-4059-77-68). Dep. CFSTI.

Phase II of the development of high-temperature thermal insulation is described. Thoria powders containing small (1/μ), medium (~20 μ), and large (~50 μ) particles were purchased. Spraying experiments established that the deposited particle size is independent of the spray mixture rolling time and the spray gun pressure. The deposited particles were the same size as the original particles. In order to standardize the spray pass, an automated foil spraying apparatus has been designed and fabricated. 400 feet of 1 mil tungsten foil and 50 feet of $\frac{1}{2}$ mil tungsten 25% rhenium foil has been purchased. The tungsten will be chemically etched to $\frac{1}{2}$ mil. The ability to deep draw thin molybdenum foil cups has been developed. These cups can be used to fabricate insulation corner assemblies. The Phase I computer program is being revamped to analyze a concentric cup corner. (auth)

8302 (MLM-1439) THERMAL DIFFUSION COLUMN COEFFICIENTS FOR THE SEPARATION OF ^{14} ^{14}N-^{14} ^{15}N AND ^{16} ^{16}O-^{16} ^{18}O. Kaminski, K. J.; Rutherford, W. M.; Willis, M. S. (Mound Lab., Miamisburg, Ohio). Sept. 26, 1967. Contract AT-33-1-GEN-53. 163p. Dep. CFSTI.

Thesis. Submitted to Univ. of Dayton, Ohio.

The Jones and Furry thermal diffusion column coefficients H′, K_c', and K_d are compared to those obtained from experiment at column temperatures of 500 and 800°C for the separation of the ^{14,14}N-^{14,15}N and ^{16,16}O-^{16,18}O isotopes. The thermal diffusion column transport equation was developed from general kinetic theory expressions that describe the mass flux resulting from a concentration and temperature gradient. This equation contains a collection of integrals represented by the column coefficients H′, K_c', and K_d. In order to evaluate the column coefficients, among other things, the temperature dependence of the viscosity, thermal conductivity, diffusivity, and thermal diffusion factor must be obtained. A complete set of smoothed experimental transport properties between 200 and 1100°K obtained from literature are given. These values are compared to the first approximation transport properties for monatomic molecules from kinetic theory using the Lennard-Jones potential function. The thermal diffusion column coefficients are determined from experiment by measuring K_c'/H' and K_d/H' using a static column, and H′ using a flow column. The column, which is 0.750 in. in dia and 20 ft in length, is heated with a 1/16 in. dia wire. Detailed drawings of the column and accessory equipment along with operating procedures are presented. Results indicate that the Jones and Furry column theory adequately describes the separation of ^{16,16}O-^{16,18}O and ^{14,14} N-^{14,15}N in the thermal diffusion column. The ratio of the experimentally determined column coefficients to those determined theoretically for H′, K_c', and K_d are 0.974 ± 0.047, 0.954 ± 0.134, and 1.07 ± 0.056, respectively. The deviation between experiment and theory is discussed by considering the experimental and theoretical errors in the column coefficients H′, K_c', and K_d. (auth)

8303 (SC-DR-67-716) SNAP-27 CAPSULE BURIAL TESTS. Baker, F. L. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. 71p. Dep. CFSTI.

Data generated by three soil burial tests of full-scale, electrically heated, simulated SNAP-27 fuel capsules are presented. These tests were performed by Sandia Laboratory as part of the SNAP-27 Safety Test Program. The capsules were buried in bentonite, Ottawa Sand and a mixture of bentonite, Ottawa sand, and feldspar. (auth)

8304 NEUTRON SPECTRUM OF $^{238}PuO_2$. Herold, T. R. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Appl., 4: 19-22(Jan. 1968).

The neutron spectrum of $^{238}PuO_2$ was measured with a ^{6}Li fast neutron spectrometer. The neutrons derive mainly from the (α,n) reaction with ^{18}O. The spectrum shows a peak at 2.3 MeV and a maximum neutron energy of ~4.8 MeV. (auth)

8305 ASPETTI SCIENTIFICI E TECNICI DELLE APPLICAZIONI INDUSTRIALI DEI RADIOISOTOPI. Atti dell'XI Congresso Nucleare di Roma, Roma, 23–24 Giugno 1966. (Scientific Aspects and Techniques of Industrial Applications of Isotopes. Reports of the XI Rome Nuclear Congress, Rome, June 23–24, 1966. Rome, Comitato Nazionale Energia Nucleare, 1967. 384p. (CONF-660661). DTIE.

Twenty-four papers on the scientific aspects and techniques of industrial applications of isotopes are presented. Separate abstracts were prepared for each paper. (L.C.L.)

For abstracts of individual papers see: 8214, 8260, 8261, 8306–8326.

8306 ACTIVITIES OF THE INTERNATIONAL ATOMIC ENERGY AGENCY IN THE FIELD OF INDUSTRIAL APPLICATIONS OF RADIOISOTOPES. Beswick, C. K. (International Atomic Energy Agency, Vienna). pp 33-40 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The program of the International Atomic Energy Agency for assisting its 96 Member States in the promotion of industrial use of radioisotopes is described. This assistance includes advisory and field services, laboratory services, research and fellowships grants, and information services. (L.C.L.)

8307 POWER FROM RADIOISOTOPES. Perret, R. P. (European Nuclear Energy Agency, Paris). pp 41-60 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The work of the European Nuclear Energy Agency in investigating the future European applications of isotopic generators is described. A survey was made of existing isotopic generators throughout the world, and the characteristics, cost, and performance of these generators are tabulated. European needs for such generators and the possibilities for their production in Europe are presented. It is concluded that ENEA work in acquainting potential users with the economic and technical advantages of isotopic generators will promote their development and use in Europe. (L.C.L.)

8308 EURATOM PROGRAMS DESIGNED TO PROMOTE THE UTILIZATION OF ISOTOPES IN THE INDUSTRY OF THE EUROPEAN COMMUNITY OF ATOMIC ENERGY. Propsti, M. G. (EURATOM, Brussels). pp 63-76 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The Euratom program to promote the utilization of isotopes in industry is discussed. Specific devices and techniques used in the natural gas industry, the mining industry, and the metallurgical industry are described. The dissemination of information by the information and documentation section is also cited. Cooperation with industry in specific programs is illustrated by a contract with the textile industry. The economic, legal, and social aspects of the utilization of isotopes are briefly indicated. (J.S.R.)

8309 ANALYSIS OF THE PROSPECTS FOR THE DEVELOPMENT OF RADIOISOTOPIC SYSTEMS FOR SPACE USE. Contzen, J. P. (CECLES/ELDO, Paris). pp 77-87 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The different types of radioisotopic systems for space use are reviewed. The problems which have prevented a broader application of isotopes in the space sector are examined. On the basis of this analysis the prospects of long-term development are deduced, especially from the European viewpoint. (J.S.R.)

8310 REVIEW ON THE ACTIVITY OF VARIOUS ASSOCIATIONS, MEMBERS OF FORATOM, IN THE REGION OF RADIOELEMENTS. Torresi, F. (Foratom, Paris). pp 89-101 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The evolution of the activities of the Atomic Forum of Italy, Spain, Belgium, Switzerland, France, Great Britain, German Federal Republic, The Netherlands, Sweden, Norway, and Denmark in the area of radioisotopes is briefly reviewed. (J.S.R.)

8311 THE PRESENT STATE AND POSSIBLE FUTURE OF THE USE OF RADIOISOTOPES IN ITALIAN INDUSTRY. Masi, O. (Centro Sperimentale Metallurgico, Rome). pp 103-15 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The group organized for the dissemination of information and knowledge on radioisotopic techniques to industry is briefly described and compared with similar organizations in other European countries. The number of industries in Italy making use of radioisotopes are tabulated according to type. The probable future development of the use of radioisotopes in Italy is outlined. (J.S.R.)

8312 ADMINISTRATIVE PROCEDURES OF SOME EUROPEAN COUNTRIES FOR THE USE OF RADIOISOTOPES IN INDUSTRY. HEALTH PHYSICS ASPECTS. Failla, L. (Comitato Nazionale per l'Energia Nucleare, Rome). pp 117-23 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The administrative procedures for the use of radioisotopes in industry are outlined for Belgium, France, German Federal Republic, Italy, Luxembourg, and The Netherlands. The emphasis is on the health physics regulations. The review affirmed that the countries have as a common base the EURATOM standard. (J.S.R.)

8313 PRODUCTION OF RADIOISOTOPES IN POWER REACTORS. Sheard, H. (United Kingdom Atomic Energy Authority, Amersham, Eng.). pp 137-45 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The suitability of power reactors for producing radioisotopes is examined. In the early stages of operation of the United Kingdom's power reactors at Calder Hall and Chapel Cross, cobalt was used as a neutron absorbing material for flux flattening and resulted in the production of ^{60}Co. Cobalt-60 continues to be produced in these reactors although at questionable cost. The ^{14}C produced in the Calder Hall power reactor by the irradiation of aluminum nitride target materials is less expensive to produce. Power reactors are not considered to be attractive for the production of isotopes other than ^{14}C and ^{60}Co. Advances in power reactor design make radioisotope production in them uneconomical. The increased reactor fuel costs required for irradiation must be examined for each particular reactor type, in order to determine whether isotope production is desirable. (L.C.L.)

8314 ACTIVITY OF THE COMMISSARIAT A L'ENERGIE ATOMIQUE IN THE PRODUCTION OF RADIOELEMENTS. Fisher, C. (CEA, Paris). pp 147-52 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The activity of the French CEA in the production of radioisotopes is part of an integrated program of international collaboration with the production centers of Belgium and Italy. The cooperation of the French CEA and CEN-Belgium in the production of the radioisotopes is emphasized. The French programs for the production of ^{60}Co sources and the separation of fission products are described. (J.S.R.)

8315 TECHNICAL AND ORGANIZATIONAL PROBLEMS IN THE PRODUCTION OF RADIOISOTOPES IN THE SORIN NUCLEAR RESEARCH CENTER AT SALUGGIA. Rosa, U. (SORIN, Saluggia, Italy). pp 153-9 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

The majority of the radioisotopes produced at Sorin are for biological applications. A typical example, the preparation of labeled albumen iodate, is described. The production of carrier-free ^{24}Na by irradiation in a fast neutron flux of a Mg matrix is also described. (J.S.R.)

8316 PRODUCTION OF ISOTOPES BY NEUTRON ACTIVATION. Slosek, T. J. (General Electric Co., Pleasanton, Calif.). pp 161-71 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23–24, 1966. See CONF-660661.

A review of United States programs for the production of radioisotopes is presented. Tables are given of the commercial producers of isotopes, categories of radioisotope production programs, United States reactor facilities used in radioisotope production, and the characteristics of the ideal radioisotope production reactor. A general prediction is made of commercial opportunities in the expanding field of radioisotope production. (L.C.L.)

8317 THE POTENTIAL FOR ECONOMIC PROFIT (AND LOSS) IN THE PRODUCTION OF ISOTOPES IN COMMERCIAL POWER REACTORS. Ransohoff, J. A. (Neutron Products Inc., Washington, D. C.). pp 175-85 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

The economic outlook for the production of radioisotopes in commercial power reactors is investigated. For this analysis, isotope production is divided into three categories: the normal production of isotopes incidental to the operation of nuclear power reactors; the increased production of certain incidental radioisotopes, specifically ^{237}Np, americium, and curium by alteration of the fuel cycle; and the deliberate production of non-incidental radioisotopes such as ^{60}Co, ^{238}Pu, ^{242}Cm, ^{244}Cm, and others. Profit estimates are made for each type of production. It is concluded that future demands for radioisotopes will profitably justify the economic risks. (L.C.L.)

8318 APPLICATIONS OF RADIOACTIVE ISOTOPES IN POLISH INDUSTRY. Gasiorowski, L. (Inst. of Nuclear Research, Warsaw). pp 225-33 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

Polish progress in the development of industrial applications of radioisotopes is summarized. These applications are mainly radiometric control systems and measuring devices. Examples are given of industrial applications in the fields of chemistry and metallurgy particularly for studying the composition of materials, the movement of liquid and solid materials through industrial processes, and physical characteristics of materials such as density and thickness. L.C.L.)

8319 POWER FROM RADIOISOTOPES. Yeats, F. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 235-42 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

The development of radioistope powered thermoelectric generators in the RIPPLE program of the United Kingdom is described. RIPPLE generators can be used in communication links, navigational aids, oceanographic research, and weather stations. The technical aspects of the program and the economics and efficiencies of such generators are outlined. Further industrial participation in the development of radioisotope powered systems is recommended. (L.C.L.)

8320 APPLICATION OF RADIOISOTOPES IN THE DEVELOPMENT OF PRODUCTS IN THE PETROLEUM INDUSTRY. Kolfenbach, J. J. (Esso Research and Engineering Co., Linden, N. J.). pp 243-53 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

The use of radioisotopes in research and development work on petroleum products at the Esso Research and Engineering Company are described. Radioactive tracer techniques are compared with conventional tracer techniques and were shown to have advantages in a number of applications. Examples are given of the use of radioactive tracer techniques in the study of fuel combustion, grease mixing mechanisms, lubricant characteristics, and wear of engine parts. (L.C.L.)

8321 APPLICATION OF RADIOACTIVE TRACERS IN THE TEXTILE INDUSTRY. Bruna, A.; Caldera, P. G. (SORIN, Saluggia, Italy). pp 255-65 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

The properties of radioisotopes, particularly those that make it valuable as a tracer, are briefly reviewed. Some specific examples are given of the uses of radioisotopes in the textile industry. These include determination of the mixing efficiency of different types of fabrics, control of the distribution uniformity, control of the straightness of the fibers, control of the degree of elimination of various additives and detergents, control of detergent efficiency, control of dyeing, and determination of the residence times in various parts of plants for the production of solutions for the preparation of artificial and synthetic fibers. Development studies being undertaken at Sorin are briefly indicated. (J.S.R.)

8322 RADIOISOTOPES IN HYDROLOGY AND IN APPLIED GEOLOGY. Cotecchia, V.; Pantanetti, F. (Comitato Nazionale per l'Energia Nucleare, Rome). pp 267-77 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

The use of radioisotopes in hydrology and applied geology are briefly outlined in order to illustrate the basic principles of this technique. The use of radioactive and stable isotopes in the measurement of water flow, variation in pressure, volume measurements, study of subterranean waters, solid transport, geotechniques, and the mining industry are considered. (J.S.R.)

8323 APPLICATION OF RADIOISOTOPES IN MECHANICAL AND METALLURGICAL INDUSTRY. Cesoni, G.; Pizzi, L. (FIAT, Turin). pp 299-336 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

Five devices using radioisotopes either as a source or as tracers were developed by Fiat. These five devices are a level measurement device, thickness measurement device, density measurement device, wear device, for control of the wear of rings and cylinders of motors, and a radiometric device to prevent collisions between cranes. The experimental techniques followed and the results obtained in the development of each device are described. The most important industrial uses that each device has found are indicated. (J.S.R.)

8324 APPLICATIONS OF RADIOISOTOPES AS TRACERS IN THE METALLURGICAL INDUSTRY. Logi, P.; Matteoli, L. (Istituto di Ricerche Breda, Milan). pp 337-45 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

New uses of radioisotopes in the metallurgical industry developed in the past few years and tracer techniques under current development are reviewed. Experimental results of the autoradiographic study of the distribution of S and P in steel using ^{35}S and ^{32}P as tracers are shown. (J.S.R.)

8325 RADIOPRESERVATION OF FOODS. Soldi, A. (SORIN, Saluggia, Italy). pp 347-55 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

The use of radiation to preserve foods is discussed briefly. The sources used, the effects of the radiation on the food and the economic possibilities are considered. Examples are given of foods preserved by irradiation. (J.S.R.)

8326 INTERNATIONAL STANDARDIZATION IN THE FIELD OF MEASUREMENT DEVICES USING RADIOISOTOPES. PROBLEMS AND ORIENTATION. Goldmann, A. (CNEN, Rome). pp 357-66 of Aspetti Scientifici e Tecnici delle Applicazioni Industriali dei Radioisotopi. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Conference on Industrial Applications of Radioisotopes, Rome, June 23-24, 1966. See CONF-660661.

The organization of an international committee for the standardization of measurement devices using radioisotopes is outlined. The primary problems to be solved are indicated. The composition of the study committee is given. (J.S.R.)

Materials Testing

Refer also to abstracts 8270, 8271, 8427, 9736, 10151, 10154, and 10167.

8327 INSPECTION. Bailey, W. J. (Battelle Memorial Inst., Richland, Wash.). pp 749-84 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

The application of inspection tests for Pu to specific situations, the equipment used, and the results obtained are discussed. Some of the methods discussed include: radiography, autoradiography, reactivity, x-ray diffraction, density times thickness gage, gamma scanning, x-ray scanning, neutron and gamma counting, swipe counting, ultrasonics, eddy current testing, resistivity, thermal tests, chemical methods, leak testing, dimensional inspection, density, weighing, mechanical tests, particle sizing, and visual inspection. (184 references). (P.C.H.)

Radioactive Material Handling

Refer also to abstracts 8201, 8253, 8254, 8258, 8260, and 8426.

8328 (NP-17195) NOTES FOR USERS OF IRRADIATION FACILITIES IN THE UTR-100 AT THE SCOTTISH RESEARCH REACTOR CENTRE. **Whitley, J. E.** (Scottish Research Reactor Centre, East Kilbride (Scotland)). [1966]. 12p. (SRRC-22/67). Dep.

The safety and legislative requirements for the irradiation of material at the Reactor Center and the removal of activated material from the site are scattered in a number of documents. Such documents are often so wide in scope that it is not easy for the general user to abstract the regulations pertaining to his particular case. An attempt has been made to resolve this difficulty by abstracting regulations applicable to most requirements for irradiations at the Center. Particular instructions are given for the presentation of samples for irradiation, and for their packaging and transport when they have been made radioactive. (auth)

8329 (ORNL-TM-2022) DESIGN AND OPERATION OF THE INTERCELL CONVEYOR SYSTEM FOR THE TRANSURANIUM PROCESSING PLANT. **Trent, T. L.** (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 33p. Dep. CFSTI.

An alpha-tight intercell conveying system has been designed, fabricated, and installed in the Transuranium Processing Plant. The system was designed to transfer relatively small radioactive items between nine cell cubicles and the transfer area cubicle rapidly and with a minimum of operator skill and attention. This system has been in operation for over a year, and its operational availability has been approximately 99%. The functional requirements, problems, design, and operation of the conveyor system are discussed. (auth)

8330 RADIOACTIVE WASTES FROM FUSION REACTORS. **Parker, Frank L.** (Oak Ridge National Lab., Tenn.). Science, 159: 83-4(Jan. 5, 1968).

Calculation of the amount of tritium released from a hypothetical fusion reaction shows that it is 2×10^4 the amount released by generation of an equivalent amount of electricity by a fission reactor. Release of the tritium generated by a power economy, if the nuclear power were all fusion, would result in unacceptable worldwide dosages by the year 2000. (auth)

8331 SAFETY CONSIDERATIONS IN THE PROCESSING OF PLUTONIUM AND RADIOACTIVE MATERIALS. **Barghusen, J. J.; Jonke, A. A.** Power Reactor Technol. Reactor Fuel Process., 10: 170-2(Spring 1967).

Compatibility studies of anion-exchange resins showed that the resin self-ignition temperature was dependent an several factors: form of the resin, type of resin, cross-linkage, loading, heating rate, volume, aging, and pretreatment. Ventilation and air cleaning systems are described. (M.C.G.)

8332 THE FINAL STORAGE OF RADIOACTIVE RESIDUALS IN THE FEDERAL REPUBLIC OF GERMANY. At. Strom, 13: 80-2(May-June 1967). (In German).

The increasing number of research and power reactors in the Federal Republic is making the problem of collection and safe disposal of the active waste products acute. One solution for low activity rates is storage in caverns. The salt mine at Wolfenbuttel used for such storage is briefly described. (J.S.R.)

8333 FACTORS IN CONTROLLING PERSONNEL EXPOSURE TO RADIATIONS FROM EXTERNAL SOURCES. **Larson, H. V.** (Battelle Memorial Inst., Richland, Wash.). pp 845-57 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

A review is presented on the hazards of plutonium handling, including radiations from plutonium isotopes, dose rate calculations, dose measurement and control, and shielding. The prevention of harmful external exposure to plutonium necessitates ascertaining the types and energies of the radiations from the various isotopes and compounds of plutonium. Radiation from those fission product contaminants that are present must also be considered. The section on shielding is limited to references on the subject and to methods of reducing the dose to the critical organs. (P.C.H.)

8334 PROCESS FOR THE DISPOSAL, IN A SMALL VOLUME OF NOXIOUS SAMPLES PLACED IN CONTAINERS AND A DEVICE FOR CARRYING OUT THE PROCESS. **Calame-Longjean, Andre; Guillet, Henri; Palli, Claude** (to Commissariat a l'Energie Atomique). British Patent 1,095,466. Dec. 20, 1967. Priority date Mar. 6, 1964, France.

A method for the disposal of samples of radioactive solutions after solution analysis is described. The solutions are placed in polythene flasks which are enclosed in capped polythene transporter tubes. The containers and sample are cooled to a temperature sufficient to freeze the samples and render the containers brittle. The contents and containers are crushed. The crushed materials are washed and the solids evacuated to a conventional and convenient storage. (F.S.)

Vacuum Engineering

Refer to abstract 8411.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 9855 and 10091.

8335 (ANL-7356) THE CODES NURF, COMBO, AND TWOSORCE FOR PROCESSING FOIL COUNTING DATA. Stanford, George S. (Argonne National Lab., Ill.). Aug. 1967. Contract W-31-109-eng-38. 87p. Dep. CFSTI.

For the routine processing of foil counting data, the codes NURF and COMBO have been written in FORTRAN for the CDC-3600, providing a variety of input and processing options. A novel feature of the NURF code is its method for treating fission-product counting data. In making decay corrections for a set of fission foils, the traditional method has been to count simultaneously a reference foil that was irradiated along with the others. The NURF code permits one to dispense with the reference foil, provided that each foil of the set is counted several times. It converts the counting rates and elapsed times (after irradiation) to logarithms, and synthesizes a decay curve by means of a least-squares polynomial fit. This step is iteratively alternated with one in which the set of counts of each foil is multiplied by the factor that causes that set best to fit the previously found curve. The COMBO code is used in conjunction with NURF to perform further normalizing and combining tasks. The program is divided into two parts. The first part provides weighted averages when the same group of foils has been counted on more than one scaler, in more than one system, or at several different times. The second part is for use in internormalizing the data from an irradiated set of foils that has been separated into two or more groups, for counting on different channels, in different systems, or at different times. Each group must include one or more foils that are common to some other group. When counting rates are greater than approximately 4,000 per second, it has been desirable to measure the deadtime for each experiment. The TWOSORCE code facilitates the routine determination of the counting-channel resolving times, using the paired-source technique. (auth)

8336 (ANU-P-387) USE OF A POSITION-SENSITIVE SOLID STATE DETECTOR TO MEASURE PROPERTIES OF A MAGNETIC SPECTROMETER. Elliott, R. V.; Carter, K. W.; Spear, R. H. (Australian National Univ., Canberra. Research School of Physical Sciences). [1966]. 26p. Dep.

A technique based upon the use of a position-sensitive solid state detector was developed for measuring properties of a 61-cm double-focussing magnetic spectrometer. It has proved particularly convenient for determining the position of the focal plane. (auth)

8337 (DUN-SA-50) FIXED RADIATION MONITORING TELEMETRY SYSTEM. Schwietert, W. E. (Douglas United Nuclear, Inc., Richland, Wash.). Nov. 1967. Contract AT-(45-1)-1857. 45p. Dep. CFSTI.

The design of the Fixed Radiation Monitor Telemetry System used by Douglas United Nuclear, which consists of transmitting equipment in each reactor area and a recording and alarm console installed at the Central Fire Station, is described. The purpose of the telemetry system is to provide a remote radiation station for the reactor buildings during an emergency radiation condition occurrence and to provide an audible and visual warning at the Central Fire Station of critical radiation alarm trips indicating area and time of occurrence on record of radiation levels. (W.H.K.)

8338 (JINR-P13-3585) REGISTRATSIYA ZARYAZHENNYKH CHASTITS S POMOSHCH'YU NITRATA TSELLYULOZY. (Charged Particle Detection With the Aid of Cellulose Nitrate). Abdullaev, Kh.; Perelygin, V. P.; Tret'yakova, S. P.; Shadieva, N. Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 9p. (In Russian). Dep.

The technique for detection of light charged particles with the aid of cellulose nitrate is developed. The threshold of response of cellulose nitrate to α-particles is determined to be ≤ 2.2 MeV, and the detection efficiency—(90 ± 7)%. The possibilities of using the cellulose nitrate detectors for the detection of heavy charged particles and for measurement of Li and B contents in matter are considered. (auth)

8339 (JUL-414-RX) GEGENWAERTIGE VERFAHREN ZUR SPEKTROSKOPIE SCHNELLER NEUTRONEN MIT HILFE VON SCHWELLWERTSONDEN. (Present Methods for the Spectroscopy of Fast Neutrons With the Help of Threshold Value Probes). Weise, L. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Oct. 1966. 50p. (In German). Dep.

In order to determine a fast neutron spectrum with a series of activation detectors a number of recently developed evaluation methods are available. The accuracy of these methods is determined by uncertainties in input data, activation, and excitation functions of a series of n different threshold detectors. The methods are compared with respect to neutron spectral data obtained in reactors. Practical indication for spectrum measurements with threshold probes is given. (tr-auth)

8340 (RFP-1068) COMPARISON OF LOW-ENERGY PHOTON DETECTORS FOR PLUTONIUM AND AMERICIUM WOUND COUNTING. Bistline, Robert W.; Tyree, William H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Dec. 18, 1967. Contract AT(29-1)-1106. 5p. Dep. CFSTI.

A lithium-drifted silicon, Si(Li), detector system was used to predict the nuclide content and apparent depth of plutonium and americium embedded in an actual wound. Data comparing the L x-ray energy resolution capability of a gas proportional and Si(Li) detector for a plutonium source were obtained. A Si(Li) detector system was used with an americium source to obtain L x-ray and low-energy gamma ray absorption data with untempered Masonite absorbers. The ratios of photon absorption obtained from the Si(Li) detector system allowed apparent depth determinations to be made. (auth)

8341 (UCID-15248) SENSITIVITY OF PHOTO ELECTRIC DIODE DETECTOR FOR SOFT FLUORESCENT X RAYS. Gaines, J. L.; Leipelt, G. R. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 27, 1967. Contract W-7405-eng-48. 6p. Dep. CFSTI.

The experimental arrangement for determining the sensitivity of a photoelectric diode to soft fluorescent x rays is described. A sodium iodide scintillation detector is utilized. (W.H.K.)

8342 USE OF SEMICONDUCTOR DETECTORS WITH ELECTRON-HOLE TRANSITIONS IN NUCLEAR INSTRUMENTATION. Matveev, V. V.; Sel'dyakov, Yu. P.; Sokolov, A. D. Izmer. Tekh., No. 10, 61-3(Oct. 1967). (In Russian).

Semiconductor detectors and their corresponding electronic equipment were developed for alpha spectrometric studies, for recording α particles during monitoring of surface contamination by radioactive materials, and thermal neutron flux measurement. The parameters of the devices with respect to the stability, integral nonlinearity, and energetic evacuation are not inhibited by foreign objects. (tr-auth)

8343 STUDIES ON SPECTRAL MATCHING OF THE RECENT PHOTOMULTIPLIERS TO VARIOUS SOLUTES IN LIQUID SCINTILLATION COUNTING. Iwakura, Tetsuo; Kasida, Yosihiko (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 16: 461-4(Sept. 1967).

A report on a comparison of the spectral matching effect of various solvent–solute combinations with recently developed photomultipliers is presented. The relative scintillation efficiency for various solvent–solute combinations was determined. The three liquid scintillation counters tested were Packard TRI-CARB 314 X, Packard TRI-CARB 3324, and Beckman CPM 200. (W.H.K.)

8344 PULSE SHAPING IN NUCLEAR AMPLIFIERS. Dance, J. B. (Univ. of Aston, Birmingham, Eng.). Instrum. Pract., 22: 57-64(Jan. 1968).

Scintillation, semiconductor and proportional nuclear radiation detectors provide output signals of an amplitude proportional to the energy donated to the detector material by the particles of the incident radiation. Information about nuclear particle energies can therefore be obtained from the output pulse amplitudes. The signal pulses from the detector must not only be amplified linearly before they are used to operate other instruments, but they must also be suitably shaped to prevent partial loss of information contained in the pulse amplitude spectrum. The basic methods of pulse shaping are discussed and some general information given as to the optimum pulse shapes in various circumstances. (auth)

8345 FULL REGISTRATION EFFICIENCY FOR GAMMA RAYS BY Ge SEMICONDUCTOR DETECTOR. Graudinya, L. Ya.; Kalnin, J.; Pelekis, L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 81-6 (1967). (In Russian).

The full registration efficiency for gamma-rays by means of a Ge semiconductor detector was calculated. The calculation is carried out for energies ranging from 0.1 to 10 MeV in case of cylindrical detector with a radius ranging from 0.25 to 2.5 cm and thickness from 0.1 to 1.0 cm for various distances from the source to the detector. (auth)

8346 DURATION OF SENSITIVE PERIOD FOR TRACK RECORDING IN MICA. **Russell, F. M. (Rutherford Lab., Chilton, Eng.). Nature (London), 217: 51-2(Jan. 6, 1968).**

There is evidence which suggests that the tracks of muons and electrons from electron showers may leave detectable marks in muscovite mica during a sensitive period following crystallization. Charged particles of higher specific ionization, such as alpha particles and fission fragments, would also be expected to leave detectable records. It has been suggested that the observable tracks may be produced as a result of exsolution of excess iron content on nucleation centers formed by ionization by the charged particles. Decoration of such centers will then occur as a result of accretion of impurities, and the original nature of the initial precipitation will be considerably masked by the continued decoration. Most crystals contain trace amounts of naturally radioactive elements, and isolated regions showing decoration by iron impurity would be expected in mica specimens showing staining. If the occurrence of such decorated regions or spots can be related to radioactive impurity content then the duration of the sensitive period for recording the passage of charged particles can be found. Estimates of this period as about 10 years were made, making use of the trace concentrations of U and Th. Although fission fragments should also produce nucleation centers, the low probability for spontaneous fission relative to alpha decay makes this a negligible contribution. Only those decays that occur after exsolution has commenced can form recordable nucleation centers. From measurements on some mica samples from the Madras region of India, the duration of the sensitive phase was found to be 16 ± 8 yr. It is unlikely that the sensitive time for the recording of muons exceeds that for alpha particles. (UK)

8347 DESIGN FOR ORIENTATION OF BALLOON-BORNE EQUIPMENT. **Anderson, Gerald A. (Univ. of Minnesota, Minneapolis). Rev. Sci. Instrum., 39: 21-5(Jan. 1968).**

The design of a system to orientate a balloon-borne instrument package about a vertical axis is presented. Pointing accuracy obtained is ±1.5°. An independent photographic recording system measures the azimuth angle with respect to the star Polaris to ±0.1°. The instrument package is rotated against a light-weight reaction wheel, which is designed for maximum moment of inertia. A pulse-width modulation system is used to drive the orientation motor. A flux-gate magnetometer, used for the sensor element, causes the instrument package to be orientated with respect to the horizontal component of the earth's field. The instrument, a gamma-ray telescope, is oriented in the north-south plane and is tilted at an angle with the vertical which will correspond with the elevation of the suspected gamma-ray source when the source crosses the local meridian. (auth)

8348 RESONANCE SELF-SCREENING TECHNIQUE FOR THE MEASUREMENT OF EPITHERMAL NEUTRON SPECTRA. **Connolly, J. W.; Wall, T.; Rose, A. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nucl. Appl., 4: 31-6(Jan. 1968).**

An experimental method of measuring epithermal neutron spectra by use of resonance activation detectors is presented. Measurements of the change in cadmium ratio with varying dilutions of the same isotope are related to the self screening properties of selected neutron resonances. The neutron spectra obtained in this way are compared with time-of-flight measurements. A wide range of ^{235}U- or ^{233}U- fuelled, BeO-moderated, substitution lattices was studied. Marked deviation from the 1/E distribution of the epithermal spectrum was observed for lattices in which the fuel-to-moderator ratio exceeded 1 : 2000. (auth)

8349 DEAD TIME MEASUREMENT. **Granados, C. E.; Sagastibelza, F. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 373-6(Nov.-Dec. 1967).**

In a recent paper (C. E. Granados et. al. Estos Anales, 63-A, 155(1967)) the possibility of measuring dead times by a coincidence method was outlined. The extent of the validity of the approximate formula given in that paper is discussed. Some results of the coincidence method can be compared with those obtained by means of a slightly different method, the series-parallel method. (auth)

8350 MECHANISTIC IMPLICATION BETWEEN QUENCHING IN LIQUID SCINTILLATION SYSTEM AND PHOTOSENSITIVITY WITH RESPECT TO ENERGY TRANSFER. **Peng, C. T. (Univ. of California, San Francisco). J. Pharm. Sci., 56: 693-7 (June 1967).**

The general aspects of energy transfer processes in quenching of liquid scintillation systems are considered and by analogy the principle is extended to energy transfer in photosensitive biological systems with an evaluation of the use of the former as a means to elucidate the mechanism involved in the latter systems. A mechanism of energy transfer in biological systems based on the consideration of similar processes in liquid scintillation system is postulated to form a common basis for all observations on hypersensitivity to light. This consists of optical excitation of the sensitizer either directly or indirectly with intersystem crossing to the triplet state and formation of the triplet state of the acceptor from both the singlet and the triplet states of the sensitizer by energy transfer. The sequence of events is represented by a series of reactions. The intervening reactions represent a diversion of the excitation energy leading to a reduction of the quantum yield of the triplet acceptor. Once formed, the triplet acceptor will have a greater probability for participation in many biological reactions because of its long lifetime. The acceptor in photosensitive biological systems will be proteins, nucleic acids, and other normal tissue constituents. The postulated scheme for photosensitive action may account for a lack of photosensitivity in many individuals by a quenching mechanism which diverts the excitation energy away from the target acceptor. (BBB)

8351 NUCLEAR RADIATION DETECTORS. DETERMINATION OF γ-PHOTON ENERGIES BY A SILICON SEMICONDUCTOR COUNTER. III. **Kitazawa, Kiyoko; Kenmochi, Kazuo (Technical Research and Development Inst., Japan Defense Agency). Giho (Boeicho Gijutsu Kenkyu Honbu), 5: No. 38, 17-27(Apr. 1966). (In Japanese).**

During the investigation of the properties of a semiconductor in the design of a nuclear radiation detector, a study was made on the determination of γ-photon energies from the Compton edge. A Li-drifted Si detector, with an effective area of 20 mm^2 and effective thickness of 2.5 mm; ^{137}Cs (0.662 MeV) or ^{207}Bi (1.064 MeV and 0.569 MeV) as a source; and an ordinary γ-ray spectrometer were used in the experiments. The relation between the Compton edge E_{em} and the energy $h\nu$ of incident γ-photons is given as $h\nu = \frac{1}{2}\,(E_{em} + \sqrt{E_{em}^2 + 2\ mc^2\ E_{em}})$. The absorbed Compton edge (at liquid nitrogen temperatures) was considerably diffused due to the statistical properties of the radiation and the noises in the circuits. Using an electronic computer NEAC-1103, the accurate Compton edge was determined from the mathematical estimation under normal distribution of the errors, in each channel of the γ-spectrometer. These studies are expected to contribute to making the size of nuclear radiation detectors small. (NSA of Japan)

8352 FAST NEUTRON FLUENCE DETECTION WITH NIOBIUM. **Hegedus, Ferenc (Swiss Federal Inst. for Reactor Research, Wurenlingen, Switzerland). Nukleonik, 10: 225-6 (1967).**

The use of niobium for fast neutron fluence detection by the reaction ^{93}Nb(n,n′)^{93m}Nb is discussed. This is an activation technique based on the emission of x rays when the isomeric level of ^{93m}Nb decays to its ground state. Errors due to the uncertainty in the activation cross section are also discussed. (W.H.K.)

8353 ENERGY LOSS AND STRAGGLING OF HIGH-ENERGY MUONS IN NaI(Tl). **Bellamy, E. H. (Stanford Univ., Calif.); Hofstadter, R.; Lakin, W. L.; Cox, J.; Perl, M. L.; Toner, W. T.; Zipf, T. F. Phys. Rev., 164: 417-20(Dec. 10, 1967). (SLAC-PUB-324).**

Absolute values of the most probable energy loss and the energy-loss straggling for high-energy muons passing through NaI(Tl) have been measured over the muon momentum range from 0.5 to 10.5 GeV/c. The results agree, within the 1% experimental uncertainty, with the theoretical values. (auth)

8354 SODIUM IODIDE CRYSTAL–PHOTOMULTIPLIER TUBE COMBINATIONS. **Carlson, R. W. (Harshaw Chemical Co., Cleveland). pp 1-14 of Scintillation Spectroscopy of Gamma Radiation. Vol. I. Shafroth, Stephen M. (ed.). New York, Gordon and Breach Science Publishers, 1967.**

Design considerations involved in ordinary and specialized scintillation detectors, particularly thallium-activated sodium iodide, are discussed. Resolution performance and stability are also considered. (W.H.K.)

8355 USE OF UNACTIVATED SODIUM IODIDE. **Beghian, L. E.; Kegel, G. (Massachusetts Inst. of Tech., Cambridge). pp 15-32 of Scintillation Spectroscopy of Gamma Radiation. Vol. I. Shafroth, Stephen M. (ed.). New York, Gordon and Breach Science Publishers, 1967.**

Detectors employing cooled unactivated sodium iodide were investigated because of their nanosecond timing of low-energy gamma rays. The purpose and uses of the cooled sodium iodide detector, energy resolution and temperature effects, electronic equipment, and energy and time resolution are discussed. (W.H.K.)

8356 DETECTORS SENSITIVE TO GAMMA RAY POLARIZATION. McCallum, G. L. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.); Vervier, J. pp 183-266 of Scintillation Spectroscopy of Gamma Radiation. Vol. I. Shafroth, Stephen M. (ed.). New York, Gordon and Breach Science Publishers, 1967.

The development of detectors and methods used to measure both the linear and circular polarization of gamma radiation is outlined, and the fundamental theory is presented. The Compton scattering process is discussed, and the construction and calibration of Compton-scattering polarimeters are described. (W.H.K.)

8357 PROPORTIONAL COUNTER WITH A LARGE WINDOW. Sanin, A. A.; Zharko, A. V.; Kuz'mitskii, A. I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 115-17(Mar.-Apr. 1967). (In Russian).

A simple, compact two-window counter is described. The window area is 23.5 cm^2, the chamber volume is 27 cm^3, the external dimensions are 10.7 cm × 4.6 cm × 1.2 cm, and the capacitance is 9.6 pF for a filament of 25 μ. The working voltage is 1.5 kV and the pulse height is 4 mV. The experimentally measured efficiency for 6- and 8-keV agrees with the calculation. (ATD)

8358 TRANSISTORIZED SIX-CHANNEL RADIATION-PROTECTION CHECKING INSTRUMENT. Burger, Gaborne; Vajda, Ferenc. Mere. Automati., No. 4, 135-40(1967). (In Hungarian).

The Multichannel Universal Dosimetric System (TUDOR), designed for central data processing and developed in the Central Research Institute of Physics, is described. The instrument measures and records β, γ fast and slow neutron-detector signals in six independent channels at a great distance from the detectors at an average count 1 to 10^4 pulses per second on a logarithmic scale, with a constant statistical error. The built-in alarm and signaling system allows varied application of the instrument. (JPRS)

8359 LARGE-AREA SCINTILLATION DETECTORS. Chudy, Martin; Seman, Michal (Komensky Univ., Bratislava). Fyz. Cas., 17: No. 2, 82-7(1967). (In Czech).

The article describes the design and characteristics of large-area scintillation detectors with prismatic Plexiglas light guides. It is shown that when this method of light collection and two 61 PK 412 photomultipliers are used the response of a scintillation detector with an area of 50 × 50 sq cm is uniform to within 4.1% except the corners near the photomultipliers, where the pulse height increases to 8% more than the value in the center. (JPRS)

8360 QUANTITATIVE CALIBRATION OF X-RAY FILM RESPONSE IN THE 5-keV TO 1.3-MeV REGION. Dozier, C. M.; Gilfrich, J. V.; Birks, L. S. (Naval Research Lab., Washington, D. C.). Appl. Opt., 6: 2136-9(Dec. 1967).

Response vs energy was measured for Kodak No-Screen and Rapid-Process films. Monochromatic incident radiation was obtained by fluorescent excitation of the characteristic x-ray lines in an element such as copper followed by crystal diffraction to pass only the Kα component. Fluorescing elements from atomic number 23(V) to 60(Nd) covered the energy range 4.95–37.0 keV. A single point at 1.25 MeV was obtained for gamma radiation from ^{60}Co. A proportional detector measured the incident flux density (photons cm^{-2} sec^{-1}). The No-Screen film is more sensitive than Rapid-Process film and has greater contrast. At 8 keV, to obtain a photographic density of unity requires 3.76 × 10^7 photons/cm^2 for No-Screen film and 4.19 × 10^7 photons/cm^2 for Rapid-Process film; at 20 keV, No-Screen film requires 7.47 × 10^7 photons/cm^2 and Rapid-Process film requires 12.87 × 10^7 photons/cm^2. (auth)

8361 CHANNELS RATIO COLOUR QUENCHING CORRECTION IN CHERENKOV COUNTING. Stubbs, R. D.; Jackson, A. (Atomic Energy Research Establishment, Harwell, Eng.). Int. J. Appl. Radiat. Isotop., 18: 857-8(Dec. 1967).

The measurement of beta particle emitting nuclides in aqueous solution by detecting the Cherenkov radiation produced, using a liquid scintillation spectrometer, has been described by Haberer and others. The effect of the presence of colored materials on detection efficiency was investigated and it showed that the channels ratio technique can be applied to such samples to determine the detection efficiency as an alternative to chemical decoloration. (auth) (UK)

8362 APPARATUS FOR MEASURING THE STRENGTH OF RADIOACTIVE SOURCES. Bradley, John Ernest Stobart (to National Research Development Corp.). British Patent 1,095,162. Dec. 13, 1967. Filed Mar. 19, 1964.

A radiation detector system designed to minimize background counts is described. The response of the detector system to the source being measured is modulated, whereas the response to background count is not modulated. Two scintillation detectors are utilized. (W.H.K.)

8363 NEUTRON-TEMPERATURE DETECTING DEVICE. Fuketa, Toyojiro (to Japan Atomic Energy Research Inst.). Japanese Patent 1966-21520. Oct. 21, 1966. Filed Sept. 28, 1961.

The proposed neutron-temperature detecting device is based on two principles: one for measuring the neutron temperature of a Maxwellian distribution by use of a 1/V absorber, and the other for measuring the absorption cross-section of neutron absorbers by moving in-pile the absorber. By the method, the neutron temperature of a Maxwellian distribution in a nuclear reactor, for example, can be easily measured at any point within the reactor. Another advantage to this method is the possibility of its use in very high temperature regions, thermally shielded by such a material as graphite. A neutron detector in the form of a column, and a cylindrical neutron-absorber surrounding the detector, which moves axially, are installed in a container which is concentric to the column and cylindrical body. The temperature of Maxwellian-distribution neutrons is obtained by means of the detector outputs when the absorber is and is not in motion. (NSA of Japan)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 9042, 9046, 9452, 9758, 9802, 9921, 9951, and 9984.

8364 (CONF-670305–, pp 255-68) A METHOD OF INFERRING QUALITY FACTOR USING THE BONNER SPECTROMETER. Holeman, George R. (Yale Univ., New Haven, Conn.).

An approach which attempts to determine the first-collision dose, dose equivalent, and quality factor for a given field of mixed accelerator-produced radiation which is predominantly neutrons is described. The instrumentation used was a spherically moderated detector and a multisphere spectrometer. (B.G.D.)

8365 (EGG–1183-387) ANALYSIS OF THE CURVED CRYSTAL SPECTROGRAPH. Technical Report Number B-3596. Wing, Paul G. (EG and G, Inc., Boston, Mass. Systems Div.). June 30, 1967. Contract AT(29-1)-1183. 117p. Dep. CFSTI.

An analysis of a curved crystal X-ray spectrograph developed at the U. S. Naval Research Laboratory is presented. The instrument consists of a lithium fluoride crystal bent into a quarter circle so that a continuous spectrum passing through an entrance slit is analyzed by diffraction into a continuous display analogous to an optical spectrogram. Using (200) diffraction, an energy span of nearly a decade can be achieved. By suppressing the (200) spectrum and looking at the (400) reflection, this span can be extended. Instrument characteristics such as detector plane irradiance, energy dispersion, line broadening, energy resolution, and signal-to-noise ratio are derived in terms of crystal parameters and the dimensions of the instrument. Both broad and point sources are considered. No comparisons with experimental data have been made. (auth)

8366 (NP–17188) CONSTRUCTION OF AND MEASUREMENTS WITH A BETA-RAY SPECTROMETER FOR ELECTRON-GAMMA CORRELATIONS. van Krugten, Hans (Technische Hogeschool, Delft (Netherlands)). [1967]. 89p. Dep.

Thesis.

A survey is made of different types of beta spectrometers in order to select the best one suitable for several purposes, e.g. for electron-gamma correlation experiments. The sector type spectrometer with a $B = B_0/r$ field and with an opening angle (angle between the planes of the pole faces) of 20° was chosen. After the construction was completed a value of about 1.5 for the ratio of transmission and resolution was obtained. The maximum transmission was found to be about 2%. The best resolution is about 0.5% for sources with a diameter of 2 to 3 mm. The influence of stray fields upon a second spectrometer (generally a NaI(Tl)-crystal equipped with a photomultiplier) for directional correlation measurements was made negligibly small by surrounding the multiplier by magnetic shields. To produce radioactive sources for beta-ray spectroscopy a vacuum deposition instrument was built. A new type of crucible leading to improved efficiency was designed. Several measurements carried out with the spectrometer are described. The shape of the low energy part of the beta continuum of the 962 keV branch in the decay of ^{198}Au was investigated by comparing this spectrum with that of the 913 keV beta branch in the decay of ^{69}Zn. The latter is assumed to have statistical shape. The shape of the 962 keV branch was found to be statistical above 80 keV. Beta spectra from the decay of ^{226}Ac and from the decay of the daughter products of

^{225}Ac were investigated. Various measurements were performed on the decay of ^{154}Eu. Six beta branches were found in this decay (so far only four were known). The K/L and L/M ratios for the internal conversion of the 123 keV transition in the daughter nucleus ^{154}Gd were measured. The K/L ratio proved to be in good agreement with an E2 character for this transition; the L/M ratio agrees well with the result obtained by applying the semi-empirical method Chu and Perlman. By means of gamma-gamma and conversion electron-gamma correlation experiments the $b_2(e_{\bar{K}}$, 123 keV) and the $b_2(e_{\bar{L}}$, 123 keV) particle parameters were measured. They are in good agreement with other measurements but deviate considerably from the theoretical values. (auth)

8367 (NP-17189) DOUBLE FOCUSING BETA-RAY SPECTROMETER APPLIED IN HEAVY ELEMENT STUDIES. Lourens, Willem (Technische Hogeschool, Delft (Netherlands)). 1967. 98p. Dep.

Thesis.

The design and construction of a magnetic beta spectrometer using iron pole pieces to obtain a double-focusing field shape are described. Results of an investigation of the decay of actinium-225 and -226 are also presented. (W.H.K.)

8368 (AERE-Trans-1080) A HIGH-RESOLUTION SPECTROMETER FOR VERY SLOW NEUTRONS FOR USE WITH THE COLD SOURCE OF A HIGH FLUX REACTOR. Scherm, R. (Kernforschungsanlage, Juelich (West Germany)). Translated by M. C. Wilson (Atomic Energy Research Establishment, Harwell, Eng.), from report JUL-295-NP. 20p. Dep. CFSTI. UK 3s. 6d.

There is a considerable interest in the investigation of neutron scattering with small momentum transfers. The analysis in phase space, which is described, indicates that examination of this scattering should, for intensity reasons, be carried out with as small an incident energy as possible. A spectrometer for studies using very small incident energies is described. This comprises a double chopper, with a neutron guide placed between the choppers, and for some cases also between the sample and the counter. The apparatus is designed for neutrons from 4 to 25 Å, and the energy resolution is variable between 0.4 and 5%. In designing the double chopper a rotating disc was found preferable to the conventional chopper. The spectrometer can also be used for high energy transfer experiments. The most difficult problem with the arrangement is probably the overlapping of cycles. Instruments with crystal monochromators are also considered, and a rotating crystal spectrometer and a triple-axis spectrometer are briefly discussed. (UK)

8369 A CALCULATION OF THE EFFICIENCY OF THREE-CRYSTAL NaI PAIR SPECTROMETERS AND OPTIMALIZATION OF THE CENTRAL CRYSTAL. Hofmann, M.; Sandrock, F. Atomkernenergie, 13: 45-9(1968). (In German).

The efficiency of scintillation-pair-spectrometers with NaI crystals represented by a product of several factors is calculated by giving these factors, and it is shown how to get an optimal efficiency. In addition, the characteristic behavior of the efficiency of pair spectrometers with semiconductor-central detectors is discussed. (auth)

8370 BETA SPECTROMETER WITH AN INTERMEDIATE IMAGE ADAPTED FOR MEASURING $\beta\gamma$ COINCIDENCES. Veis, M.; Kokesh, A. (Inst. for Nuclear Research, Prague). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 650-5(Apr. 1967). (In Russian).

A Siegbahn–Slätis intermediate-image-type β spectrometer was adapted for $\beta\gamma$ coincidence measurements by redistribution of the scintillation counters in the pole terminals and compensation of magnetic field disturbances. The electronic equipment is described. The instrument was calibrated by measuring β coincidence using a ^{198}Au source. The newly established instrument parameters are reported. (JPRS)

8371 STABILIZER OF RADIATION SPECTRA. Campos, J.; Butragueno, J. L. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 377-80(Nov.-Dec. 1967). (In Spanish).

A gamma spectrum stabilizer was designed. The system corrects the gain drifts of the detector head by a factor of twenty four times and within a linear range of a ±30% from the initial position. The stabilizer uses two single channel analyzers with the windows placed on both sides of a peak of the spectral distribution. The outputs from two linear ratemeters attached to the analyzers are compared in a differential amplifier. This provides a correction signal which is fed into the high voltage control so as to change the high voltage and therefore the gain of the photomultiplier. (auth)

8372 X-RAY SPECTRA FROM DENTAL X-RAY GENERATORS. PART II. THE PRIMARY BEAM. Garcia, Daniel A. (Tufts Univ., Boston). Oral Surg., Oral Med., Oral Pathol., 23: 610-26(May 1967).

Methods were developed for measuring the photon distributions resulting from dental x-ray beams. X-ray spectrometry by sodium iodide scintillation was used to measure beams from 4 diagnostic x-ray machines. The 100-channel pulse-height analyzer used was calibrated to 2 isotopes and K-shell radiation from 7 elements as fluorescent radiators. The K shells of the radiators were excited by collimated beams from x-ray machines, and the K radiation was measured at 90° to the beam axis. Over 100,000 photon counts per total experimental spectrum were accumulated. Experimental photon distributions were compared to corresponding theoretical models (mainly, appropriate modifications of the Kramers expression for bremsstrahlung radiation from a thick target). In general, the fit of measured data to predicted models is reasonably good at energy levels below 100 keV. An equation could be used to represent accurately the composition of an x-ray beam with respect to the relative numbers of the component energies and the equation could be evaluated for any desired control setting of the x-ray machine. Thus, theoretically derived distributions could be substituted for laborious direct measurements in problems requiring a knowledge of x-ray beam composition. Generators of several brands were studied to detect possible influences of minor variations in electrical construction on their respective distributions. In addition, all machines were measured under normal operating conditions of tube voltage, filtration, and tube current. (BBB)

8373 EXPERIMENTAL DETERMINATION OF ENERGY SPECTRUM OF MEGAVOLTAGE X-RAYS. Inada, Tetsuo; Sakata, Suoh (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 671-6(Sept. 1967). (In Japanese).

A sintillation spectrometer consisting of a 5 inch (diameter) by 4 inch (length) NaI(Tl) crystal, two photomultipliers and the rest has been prepared for studying the x-ray spectra from a betatron. Since the response function of the detector is needed to relate the measured pulse height distributions to the true energy spectrum, measurements of the pulse height distributions have been made with this spectrometer for monoenergetic gamma rays with known energies from 1.28 to 20.3 MeV. Thus, the response function and its inverse matrix have been calculated for photon energies from 1.5 to 30.0 MeV. X rays from the betatron have been measured with this spectrometer, being corrected by means of the inverse matrix method. The energy spectra are presented for 15 and 25 MeV x-ray beams with and without absorbers (water and aluminum). (auth)

8374 APPLICATION OF THE GRIDDED IONIZATION CHAMBER TO ALPHA SPECTROMETRY. Doke, Tadayoshi; Kikuchi, Jun (Waseda Univ., Tokyo). Waseda Daigaku Rikogaku Kenkyusho Kokoku, No. 36, 104-14(Sept. 1966). (In Japanese).

A voltage pulse induced on the grid closer to the cathode in a double-grid ionization chamber, which contains a directional information of alpha track, has been used by several workers for the reduction of background counts due to alpha particles, or the measurement of angular distribution of heavy charged particles produced by nuclear reactions. In the double-grid chamber, however, the electric field between collector and grid or two grids must be higher than that in a single grid chamber for the elimination of the capture of electron by the grid. Since the use of high field in the chamber operation gives trouble, it is attempted by us to use the cathode pulse in the single-grid chamber in place of the grid pulse in the double-grid chamber. This paper describes the design and construction of a cylindrical chamber with a single grid, in which the cathode pulse is used for the reduction of alpha ray background and also, the principle of measurement of alpha-gamma directional correlation by using the cathode pulse in a parallel plate single grid chamber including a NaI crystal and the results for ThC and ThC′. (auth)

8375 RECORDING SPECTRA OF PARTICLES WITH MOMENTA UP TO 400 MeV/c WITH A MAGNETIC SPECTROMETER. Afanas'ev, N. G.; Gol'dshtein, V. A.; Savitskii, G. A.; Stepula, E. V.; Khvastunov, V. M.; Shevchenko, N. G. Zh. Tekh. Fiz., 37: 1671-6(Sept. 1967). (In Russian).

A nuclear emulsion recording technique has been used in earlier work with a magnetic spectrometer that was designed to record particles with momenta up to 400 MeV/c and has been described elsewhere by N. G. Afanas'yev and various collaborators. Tests to which the spectrometer and recording technique have been subjected are described. Plates with 100 u thick nuclear emulsion coatings were employed. The background count was reduced by a factor of 10 by counting only those tracks whose directions were close to that calculated for a particle following a spectrometer trajectory. Lines could be simultaneously recorded over a momentum range extending for 5% on each side of the central momentum value for which the spectrometer was adjusted, without serious deterioration of the resolution (0.11% for a 4.5 mm diameter source) achieved in the center of the range. The transmission factor of the spectrometer in the center of the ±5% particle momentum range was in good agreement with the value of 0.0029 sterad previously found with scintillation counter measurements, but was 25% lower at the edges of the particle momentum range. (ATD)

8376 MODERN EXPERIMENTAL NUCLEAR PHYSICS. **Kamke, Detlef (Ruhr-Univ., Bochum, Ger.). pp 279-306 of Festschrift zur Eroeffnung der Universitaet Bochum. Wenke, Hans; Knoll, Joachim H. (eds.). Bochum, Verlag Ferinand Kamp, 1965. (In German).**

Some problems and questions of experimental nuclear physics are introduced. Details of nuclear reactions are explored, and handling of experimental data obtained in studies of nuclear reactions outlined. A variety of devices for detection of radiation are introduced, particularly the Si semiconductor radiation detector. A particle spectrum obtained with a Si semiconductor detector is illustrated. After a discussion of particle spectroscopy, the measurement of gamma spectra by scintillation methods is introduced. The layout of a typical instrument is shown, and the analysis of a 5-component spectrum is illustrated. Spectra obtained from a Ge–Ni detector and a scintillation detector are compared. Some discussion of accelerators in low-energy nuclear physics is also given. (BBB)

8377 SCINTILLATION SPECTROSCOPY OF GAMMA RADIATION. VOLUME I. Shafroth, Stephen M. (ed.). New York, Gordon and Breach Science Publishers, 1967. 452p. $26.50.

A separate abstract was prepared for each of the eight chapters presented. (W.H.K.)

For abstracts of individual chapters see: 8354–8356 and 8378–8382.

8378 BACKGROUND, SHIELDING, AND COLLIMATION. Kreger, W. E.; Mather, R. L. (Naval Radiological Defense Lab., San Francisco). pp 33-141 of Scintillation Spectroscopy of Gamma Radiation. Vol. I. Shafroth, Stephen M. (ed.). New York, Gordon and Breach Science Publishers, 1967.

The sources of radiation background, shielding to reduce background, and collimation, particularly applied to gamma scintillation spectroscopy, are discussed. Background due to radioactive contamination, neutron flux, cosmic rays, and spurious electronic pulses are discussed. Attenuation and buildup, fluorescent radiation, Compton scattering, pair production, and low background shielding are discussed. Purposes of collimation, properties of materials, characteristics of collimators, collimator design, experimental measurements, and multichannel collimators are also considered. (W.H.K.)

8379 RESPONSE OF SODIUM IODIDE TO NEUTRONS. Shafroth, S. M. (Bartol Research Foundation, Swarthmore, Pa.). pp 143-62 of Scintillation Spectroscopy of Gamma Radiation. Vol. I. Shafroth, Stephen M. (ed.). New York, Gordon and Breach Science Publishers, 1967.

Thallium-activated sodium iodide scintillation detectors used for gamma spectroscopy are also sensitive to neutrons. This response of sodium iodide to neutrons is found to be dependent on the energy of the neutrons, the size and shape of the crystal, and the materials which directly surround the crystal. (W.H.K.)

8380 COMPTON SPECTROMETERS. Braid, T. H. (Argonne National Lab., Ill.). pp 163-82 of Scintillation Spectroscopy of Gamma Radiation. Vol. I. Shafroth, Stehen M. (ed.). New York, Gordon and Breach Science Publishers, 1967.

Gamma spectroscopy by coincidence detection based on the Compton effect is described. The Compton effect, spectrometer characteristics, efficiency, and uses for Compton spectrometers are discussed. Thallium-activated sodium iodide detectors are used. (W.H.K.)

8381 SINGLE CRYSTAL SPECTROSCOPY. Mueller, R. (Eidgenoessische Technische Hochschule, Zurich); Maeder, D. pp 267-370 of Scintillation Spectroscopy of Gamma Radiation. Vol. I. Shafroth, Stephen M. (ed.). New York, Gordon and Breach Science Publishers, 1967.

The complex response functions encountered when scintillation detectors are used for gamma spectroscopy are analyzed. The primary interactions involved, a theoretical calculation of the response function, instrumental smearing, and experimental results on response functions are discussed. (W.H.K.)

8382 UNFOLDING MEASURED DISTRIBUTIONS. Monahan, J. E. (Argonne National Lab., Ill.). pp 371-428 of Scintillation Spectroscopy of Gamma Radiation. Vol. I. Shafroth, Stephen M. (ed.). New York, Gordon and Breach Science Publishers, 1967.

A review of methods for unfolding the output data of a detection system to obtain information about the corresponding physical input distribution is presented. The methods are applicable to analysis of pulse-height distribution of gamma scintillation spectrometers. Topics include the response operator, analysis of discrete spectra, systems of linear equations, error analysis of the measurement equation, and continuous spectra. (W.H.K.)

High Energy Physics Instrumentation

8383 (JINR-P1-3595) K VOPROSU IDENTIFIKATSII SOBYTII V PROPANOVYKH KAMERAKH. **(On the Problem of the Events Identification in the Propane Bubble Chambers). Ivanov, V.; Yanoutova, L. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 16p. (In Russian). Dep.**

Different methods of events identification in a propane bubble chamber are compared. It is shown that a kinematic analysis of the events, in this case, can play an auxiliary role, while for the particle identification ionization measurements are to be taken. (auth)

8384 (JINR-P13-3570) IMPUL'SNYE RAZRYADNIKI S RAZLICHNYMI PODZHIGAYUSHCHIMI ELEKTRODAMI. (Impulse Discharger with Different Keep-Alive Electrodes). Pisarev, A. F.; Sheshunov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 13p. (In Russian). Dep.

The results of investigation of the air impulse dischargers with the ignition systems such as: needle, closed, open and ring are given. It is shown that the dischargers of the ring and needle types are of high velocity and frequency. The dischargers of the ring system are the most reliable and permanent. The measurement results of the current and time characteristics of the dischargers mentioned are discussed in detail. (auth)

8385 ANGULAR DEPENDENCE OF THE BRIGHTNESS OF STREAMER TRACKS. **Asatiani, T. L.; Gazaryan, K. A.; Zhmyrov, V. N.; Ivanov, V. A.; Nazaryan, A. A. (Inst. of Physics, Erevan. Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 171-3(Sept. 15, 1967).**

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 684-7(Sept. 15, 1967).

The character of the variation of the brightness of streamer tracks was investigated varying the angle and also the dependence of the limiting angle (the angle at which the chamber operation goes over from the streamer mode to the tracking mode). To determine the effect of the duration of the high-voltage pulse on these characteristics, the measurements were made at two high-voltage pulse durations (40 and 42 nsec) and at electric field intensities of 10 kV/cm. (J.F.P.)

8386 IONIZATION MEASUREMENT IN A STREAMER CHAMBER. **Asatiani, T. L.; Gazaryan, K. A.; Ivanov, V. A.; Zhmyrov, V. N.; Nazaryan, A. A. (Inst. of Physics, Erevan). JETP Lett. (USSR) (Engl. Transl.), 6: 83-7(Aug. 15, 1967).**

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 571-5(Aug. 15, 1967).

The possibility of measuring the ionizing ability of charged particles in a streamer chamber, based on the brightness of the streamer tracks, was investigated. Results are reported on photometric measurements of proton tracks from a streamer chamber filled in one case with pure neon and in the other with commercial helium. (L.B.S.)

8387 CORRELATION OF THE PROPERTY OF SPURIOUS SCATTERING IN NUCLEAR EMULSIONS. **Voinov, V. G.; Chasnikov, I. Ya. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 3-8(July-Aug. 1967). (In Russian).**

On the basis of previously published data, the property of spurious scattering was examined. By means of the correlation analysis of the primary track of the charged particle, it was discovered that the self-correlation function of the spurious scattering has the form of periodic damping oscillation. This was explained by wave-like deformation of the track in the plane of the emulsion. The period of the self-correlation function, determined on nuclei of 2000 μ for the emulsion Ilford G-5 (thickness 600 μ) was found equal to ~5 mm, and for emulsions of the NIKFI-R type (thickness 400 μ) is ~2.5 mm. The spurious scattering, probably, can not be described by the concrete statistical model as the deformation of the emulsion is nonstationary. (tr-auth)

8388 USE OF AN ON-LINE DIGITAL COMPUTER IN CLOSED-LOOP HIGH-ENERGY PHYSICS EXPERIMENTS. **Friedl, Paul (IBM Corp., Palo Alto, Calif.); Sederholm, Charles;**

Dye, William; Crannell, Hall; Yearian, M. R. J. Comput. Phys., 1: 305-21(Feb. 1967).

A meta-linguistic programming approach is described which is oriented to solving the programming problems faced by a high-energy physicist in conducting on-line computer-assisted experiments. This approach is now based on conventional macros, but will be extended to include other facilities such as immediate assemble and execute and display-aided trace and debug features. Some applications of the system are described. Electrons with energies up to 1.2 GeV, produced by the Stanford Mark III 310-ft linear accelerator, were used to bombard various target materials. Electrons, or secondary particles produced by the electrons, were detected with several different kinds of detectors. Information from the detectors was relayed to the data-acquisition area where it was processed and stored, while control information was fed back to nuclear instrumentation by the computer. A description of the computer and instrument interfaces, as well as the application-oriented programming approaches used to operate these devices in various experiments, is given. Several different experiments using the data-acquisition computer system are described, and plans for future modifications and improvements are discussed. (BBB)

8389 DISCHARGE MECHANISM IN SPARK TRACK CHAMBERS. **Moestl, K.; Timm, U. (Univ., Hamburg). Z. Phys., 209: 60-7(1968). (In German).**

The operation of streamer chamber has been studied by application of image converter and image intensifier. The high voltage pulse was produced by a Marx generator (pulse duration about 15 ns), the primary ionization was generated by gas-ionizing radiation emitted by a spark lamp. There exist two modes of operation: A. When only about one primary electron per 2 cm was available, the discharges were identified as being avalanches, which developed into anode- and cathode-directed streamers, as soon as critical amplification was attained. The first 5 ns after beginning of streamer mechanism, when E/p was large streamer propagation depends strongly on E/p; the velocity of anode-directed streamer is somewhat larger than that of cathode-directed streamer. When pulse magnitude decreases strongly, the streamer velocities become nearly independent of E/p. B. Starting with about 100 electrons/cm, one gets tracks, which emit sufficient light for direct photography. The tracks are parallel to the direction of the ionizing radiation and are caused by overlapping of the local avalanches initiated by the primary electrons. (auth)

Radiation Dosimeters

Refer also to abstracts 8035, 8531, 9431, 9432, and 9730.

8390 (AHSB(RP)M-46) A SUMMARY OF RESEARCH AND DEVELOPMENT WORK CARRIED OUT IN 1966 IN HEALTH AND SAFETY DEPARTMENTS OF THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY. **Freke, A. M.; Dolphin, G. W. (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). Sept. 1967. 54p. Dep. CFSTI. UK.**

This memorandum lists 193 projects on which research or development work has been carried out in Health and Safety Departments of the UKAEA during 1966. The object of this memorandum is to provide information about current research and development work which may be helpful to those planning research programs. References are given to the published papers resulting from work carried out on the projects during the year. (auth)

8391 (BNWL-SA-1543) SOLID STATE LUMINESCENCE DOSIMETRY: STATE OF THE ART. **Wilson, Walter E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 13, 1967. Contract AT(45-1)-1830. 24p. (CONF-671121-1). Dep. CFSTI.**

From Conference on Interdisciplinary Discussion of Solid State Dosimetry, Seattle, Wash.

The state-of-the-art of solid-state luminescence dosimetry is discussed from two different view points: practical personnel dosimetry and measurements without limitations imposed by measurement methods. Some basic considerations applying to thermoluminescence and radiophotoluminescence are reviewed. The use of these materials as dosimeters is examined. The various materials currently being used, their emission spectra, glow curves, and energy response are discussed. The application of these devices for measuring low-level and high-level doses are described. (auth)

8392 (CONF-670305-, pp 329-45) RECENT RESULTS IN MACRO AND MICRO DOSIMETRY OF HIGH-ENERGY PARTICULATE RADIATION. **Baily, Norman A. (California Univ., Los Angeles. Dept. of Radiology).**

Dosimetry for health physics purposes at or around high-energy accelerators is discussed. This type of dosimetry is associated with measuring both absorbed dose and quality for an unknown radiation field. The field being composed of both primary radiation and secondary radiation produced by primary beam reactions with accelerator components, targets, and shielding materials. (B.G.D.)

8393 DISCUSSION ON THE CONDITIONS OF CHEMICAL DOSIMETRY USING A TITANIUM SULFATE SOLUTION. **Hasegawa, Kunihiko (Shizuoka Univ., Japan). Radioisotopes (Tokyo), 16: 423-7(Sept. 1967). (In Japanese).**

A simple method was developed for ^{60}Co gamma dose measurement based on the fact that titanium ion in 0.8$\underline{N}$ sulfuric acid solution is oxidized to a colored titanic complex by ^{60}Co gamma rays. In oxygen-saturated system, G(colored titanic complex) values in 0.8$\underline{N}$ sulfuric acid solution were between 0.73 and 1.28 depending on titanium-ion concentration. In nitrogen-saturated system, G value was 0.32 in 0.8$\underline{N}$ sulfuric acid solution. For the oxygen-saturated system of 2×10^{-2}M solution of titanium ion, this method is very convenient. (auth)

8394 RECENT PROGRESS IN RADIOPHOTOLUMINESCENCE DOSIMETRY. **Becker, Klaus (Juelich Nuclear Research Establishment, Ger.). Health Phys., 14: 17-32(Jan. 1968).**

The main parameters which determine the desirable dosimetric properties of silver-activated phosphate glasses (low predose, high sensitivity, low energy dependence, fast build-up and slow fading, high or low neutron sensitivity), and the possibilities for optimizing such dosimeter glasses are briefly discussed. New glasses are described which have similar gamma response characteristics but only 1−2% of the thermal neutron sensitivity of other glasses. Pairs of neutron sensitive and insensitive glasses can be used similar to ^{6}LiF/^{7}LiF in neutron dosimetry. Under optimized laboratory conditions the accuracy of dose measurements is between ±0.4 and 6%. Film and glass dosimeters were also compared under identical practical conditions (photon doses 0.06 to 870 rad, 45 to 1250 keV, frontal and 90° radiation incidence, storage 4 weeks at 20−35°C, and 0 and 80% relative humidity). Of the total glass dosimeters tested 89% (100% for doses above 5 rad) were found to give within ±30% of the actual doses, but only 18% of the film dosimeters. Using modern glass badges and readers, the organization of a personnel dosimetry service is much simpler and the costs are lower than with a comparable film service. (auth)

8395 STUDIES OF GAMMA DOSIMETRY SYSTEMS USED FOR NUCLEAR ACCIDENT DOSIMETRY. **Duffy, T. L.; Kasper, R. B. (Argonne National Lab., Ill.). Health Phys., 14: 45-9 (Jan. 1968).**

For the past 6 years the Industrial Hygiene laboratory at Argonne National Laboratory has been charged with the responsibility for assessing gamma dose in the event of an inadvertent criticality. To fulfill this responsibility it has been necessary to study several commercially obtained dosimeters and to evaluate their performances under field conditions. The three systems studied were chemical dosimeters, polyacrylamide polymer solutions, and lithium fluoride−Teflon dosimeters. Among the areas studied with these systems were response, stability, and ease of maintenance. The instrumentation involved in evaluation is, in general, conventional laboratory equipment with some modifications. (auth)

8396 TACTICAL RADIATION DOSIMETRY IN THE U. S. ARMY. **Kronenberg, Stanley (Army Electronics Command, Fort Monmouth, N. J.). Health Phys., 14: 41-4(Jan. 1968).**

The army is interested in the dosimetry problems associated with tactical warfare in which small tactical nuclear weapons might be used. Therefore a tactical dosimeter is required. This should be a high range direct reading device measuring both gamma and neutron radiation to provide a means for rapid determination of the total dose personnel have received. A quartz fiber dosimeter based on secondary electron emission in a vacuum (Radiacmeter IM-185) is under development. It is hoped that this dosimeter will satisfy all of the requirements of a tactical dosimeter. The physical principles, construction, and performance of Radiacmeter IM-185 are discussed. (auth)

8397 COMPARISON OF LITHIUM FLUORIDE AND FILM FOR PERSONNEL DOSIMETRY. **Hall, R. M.; Wright, C. N. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Health Phys., 14: 37-40(Jan. 1968). (DP-MS-66-72).**

LiF thermoluminescent dosimeters are more accurate than film badges for personnel monitoring in locations where the quality of x or gamma radiation ranges from soft to hard (e.g., plutonium refining areas). Therefore, thermoluminescent dosimeters were added to the film badges of sixty-six employees assigned to a plutonium finishing area at the Savannah River Plant to assist in the interpretation of low-energy gamma radiation exposure. During the first 6 months of 1966 the skin exposure measured by thermoluminescent dosimeters averaged one-half of that measured by the film badges. A second LiF dosimeter with copper and polyethylene filters added to the film badges of the same personnel showed that the low-energy photons also caused a similar error in the measurement of penetrating radiation exposure by the film badge. Observed differences between the LiF and film dosimetry results were reproduced under controlled conditions by giving film badges and thermoluminescent dosimeters known exposures of x and gamma radiation. LiF results were within 20% of the measured exposures; at 48 keV the film interpretation of skin dose was high by a factor of 2.0, and at 105 keV the film interpretation was high by a factor of 2.7 for the skin dose and 2.0 for the penetrating dose. (auth)

8398 ON THE USE OF PHOSPHOR-TEFLON THERMOLUMINESCENT DOSIMETERS IN HEALTH PHYSICS. Berstein, Irving A.; Bjarngard, Bengt E.; Jones, Douglas (Controls for Radiation, Inc., Cambridge, Mass.). Health Phys., 14: 33-6 (Jan. 1968).

The application to health physics dosimetry problems of thermoluminescent dosimeters consisting of phosphor incorporated into a Teflon matrix is described. Techniques of fabrication of such phosphor–Teflon dosimeters of various shapes and sizes are described. Examples of the geometrical forms that have been used are discs with diameters between 6 and 13 mm and thicknesses from 0.02 to 0.5 mm, rods of 1 mm diameter of various lengths, and tape 25 mm wide and 0.4 mm thick. The specific advantages and limitations for health physics applications of each of the three important thermoluminescent phosphors—LiF, CaF_2: Mn and $CaSO_4$: Mn—that have been incorporated into Teflon are indicated. Basis for the selection of the various dosimeter shapes and the preferred phosphor for each type of health physics application are described in detail. Finger and hand dosimetry, piggy-back TLD with film badges, and other personnel dosimetry concepts are discussed together with more general applications in health physics. (auth)

8399 TRITIUM FILM BADGE. Geiger, Eric L. (Eberline Instrument Corp., Santa Fe, N. Mex.). Health Phys., 14: 51-5(Jan. 1968).

A special film badge was developed to measure exposures to tritium. The badge response is greater for tritium in the form of water vapor, HTO, than it is for tritium in the form of gas, HT, and may be used as a tritium hazard monitor. The badge is capable of measuring exposures that would result in more than one body burden of tritium. (auth)

8400 CORRECTION OF THE ENERGY CHARACTERISTICS OF DOSIMETRIC SCINTILLATION DETECTORS. Denisenko, A. N.; Lyapidevskii, V. K. At. Energ. (USSR), 23: 249-51(1967). (In Russian).

A method was developed for correcting the energy characteristics of dosimetric scintillation detectors by measuring simultaneously the dose rate and the quality of radiation, making the required corrections, as indicated by the energy characteristics. The quality of radiation is derived from the I/N ratio, whereby I designates the mean current of the detector and N the mean pulse count rate of the counter. A 20-mm thick NaI(Tl) crystal was used as the detector. The energy characteristic η was obtained from the $\eta = I/D$ relation, whereby D is the exposure dose rate, using ^{198}Au, ^{60}Co, ^{137}Cs and filtered x radiation for the measurements. The correction factor was close to 1 for ^{60}Co, but corrections of 14 and 9% must be made for ^{137}Cs and ^{198}Au, respectively. The largest error occurs when the spectrum consists of only two lines. Use of the correction method broadens the applicability of sensitive inorganic crystals for dosimetric measurements; determination of the quality of radiation by means of scintillation detectors helps to design suitable shields. (TTT)

8401 IMPROVEMENTS IN DOSIMETERS. (to Societe Anonyme, Mfg. Belge de Lampes et de Materiel Electronique, MBLE). British Patent 1,096,251. Dec. 20, 1967. Priority date Jan. 29, 1965, Belgium.

A thermoluminescent dosimeter for investigating complex radiation is described. Two thermoluminescent materials are used which are sensitive to different types of radiation, thus allowing the simultaneous dosimetry of different types of radiation. (W.H.K.)

Radiometric Instruments

Refer also to abstract 8326.

8402 (UCRL-50329) LARGE CUBICAL RADIOMETRIC CALORIMETER. Gunn, Stuart R. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 30, 1967. Contract W-7405-eng-48. 8p. Dep. CFSTI.

An isothermal heat-flow calorimeter with a cubical sample chamber 20 × 20 × 20 in. is described. A 192-junction thermopile is used for measurement of the temperature gradient. The detection limit (noise level) is, typically, ca 5 mW, and the precision for large samples is within a few tenths of one percent. (auth)

8403 MEASUREMENTS OF CURVES OF ISODENSITY IN GRAPHITE. Gaeta, R. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 339-44(Nov.-Dec. 1967). (In Spanish).

A thickness gauge was built based on the absorption of x rays generated in a bremsstrahlung source. This method allows rapid and precise measurement (±0.6% at the 3σ level) of the densities of graphite slabs, with a thickness of 25 mm. This way isodensity diagrams were obtained. (auth)

8404 IMPROVED STANDARDS FOR NEUTRON SOIL WATER METERS. Ursic, S. J. (Dept. of Agriculture, Washington, D. C.) Soil Sci., 104: 323-5(Nov. 1967).

Economical standards made from polyethylene cylinders 2.5 to 4.5 inches in diameter proved highly satisfactory for operational checks and recalibrations of neutron soil water probe systems. They were used in conjunction with laboratory calibrations by the water-addition technique. Probes with curvilinear calibration lines were calibrated by correlating their readings with those of a system that had a linear response. (auth)

8405 METHOD OF, AND APPARATUS FOR, THE MEASUREMENT OF DENSITY WITH RADIOACTIVE NUCLEIDES. Dorfel, Gunter (to Veb Vakutronik Wissenschaftlicher Industriebetrieb Dresden). British Patent 1,095,260. Dec. 13, 1967. Filed Dec. 20, 1965.

A radiometric densimeter is described which incorporates a compensating technique to ensure a constant sensitivity. Two equivalent radiation sources are utilized, and by means of a bridge circuit the sensitivity of the scintillation detector is kept constant. (W.H.K.)

Miscellaneous Instruments and Components

Refer also to abstracts 8708 and 10104.

8406 (AERE-R-5112) SOME WAYS OF RECORDING OPTICAL SPECTRA USING IMAGE INTENSIFIERS. Iredale, P.; Ryden, D. J. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1967. 19p. Dep. CFSTI. UK 3s. 6d.

Several ways of using image intensifiers to record optical spectra are considered. The properties of image intensifier-film combinations are described. It is shown that the highest efficiency of utilisation of the incoming signal information is obtained by counting individual photoelectrons via the flashes of light they produce at the intensifier output. (auth)

8407 (GEAP-4797) CABLE FOR PULSE COUNTING AND CAMPBELLING IN-CORE INSTRUMENTATION DEVELOPMENT PROGRAM. Quarterly Progress Report, October 1964—January 1965. Neissel, J. P.; Green, W. K. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1965. Contract AT(04-3)-189. 19p. Dep. CFSTI.

The transmission of information from an ionization or fission chamber inside a reactor through a coaxial cable to the electronic equipment outside is studied. Direct-current transmission characteristics, pulse transmission characteristics, and alternating-current transmission characteristics are discussed. (W.H.K.)

8408 (TID-24192) METASTABLE IONS IN THE BENDIX TIME-OF-FLIGHT. Johnsen, R. H.; Mooberry, E. (Florida State Univ., Tallahassee). [nd]. Contract AT(40-1)-2001. 3p. Dep. CFSTI.

Two modifications were made to the Bendix mass spectrometer in order to make it suitable for the study of metastable ions. The first one allows the potential of the ion lens to be varied independently of the flight tube potential over the complete range from 0 to −2.8 kV. The second modification involves the addition of several new grids to the detector stack for varying the voltage of the stack from 0 to −2.8 kV. (B.G.D.)

8409 (TID-24203, pp 17-24) ELECTRONIC INSTRUMENTATION. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

A theoretical study was made on the CEC 21-110 mass spectrometer to improve the resolution. A theoretical study of the spatial distribution of ions in the exit focal plane as a function of the spatial and velocity distributions of ions in the input focal plane was made. Preliminary results are given. (M.O.W.)

8410 (AD-660962) SMALL-SIZE 128-CHANNEL PULSE ANALYZER. Krasheninnikov, I. S.; Kurochkin, S. S.; (and others) Translated from Yadern. Priborostr., Nauch.-Tekh. Sb., No. 1, 77-100(1964). 33p. (FTD-MT-67-04).

A small pulse analyzer, using a new ferrite data recorder, is described. Its main parts are the input unit, the data recorder, the control block, and the data readout blocks. The input unit converts the pulse height into a sequential digital code and does not differ essentially from the standard circuits used for the purpose. The new type of data recorder has three main features which increase its operating reliability and reduce the volume of the electronic equipment: A single reading winding is used in the sequential access to the number digits, a single amplifier with discriminator, and an arithmetic unit consisting of a single flipflop only. This increases greatly the operating stability. The possibility of using a half-adder consisting of a single flipflop likewise reduces the data-recorder failure probability. The reliability is also increased through the use of a small number of elements for setting the reading and writing currents and through the absence of an inhibiting current. The data recorder provides for the storage of 128 16-digit numbers, and its construction and operations are briefly described. All the other units are described in some detail. A breadboard of the analyzer was tested and the suitability of the equipment for its purpose (which is not spelled out in the article) is demonstrated. The breadboard measured 362 × 350 × 450 mm and weighed approximately 20 kg. The readout time for a single number is approximately 2 sec and for all the numbers is approximately 4 min. If only half of the channels are filled, the circuitry can be modified so as to reduce the readout time to one-half. A review of earlier attempts to design pulse analyzers that can be suitable for operation under conditions other than in the laboratory, such as in the field or in various industrial plants, is also presented. (auth)

8411 IONIZATION GAGE FOR MEASURING PRESSURES LESS THAN 10^{-10} TORR. De Taddeo, D. (Varian S.p.A., Turin). Vide, No. 131, 267-71(Sept.-Oct. 1967). (In Italian).

The low pressure performances of a Bayard-Alpert gauge are mainly limited by the photoelectrons current due to x-ray bombardment of the ion collector. This limit normally is equivalent to a pressure reading of some 10^{-11} torr. The new gauge design was studied so that the ion current produced in a conventional ionizing structure is electrostatically deflected to a remote collector. Because of this configuration, the collector is conveniently shielded from the x rays produced by the grid and the photoelectrons current is therefore reduced of a factor of better than 100. The minimum readable total pressure achieved is therefore of less than 5×10^{-13} torr. These pressure measurements were performed using an ultra-high vacuum system equipped with getter ion pump and titanium sublimation pump and chilled with liquid nitrogen. (auth)

8412 GUIDE TO SCIENTIFIC INSTRUMENTS, 1967-1968. Sciences, 158A: 364p.(Nov. 28, 1967).

A guide to the names and addresses of the manufacturers of laboratory instruments and equipment is presented. An editorial on instrumentation and information centers is included. (B.G.D.)

8413 INDUCTION PROBE FOR MEASURING LEVELS IN LIQUID METALS. Johnson, T. R.; Teats, F. G.; Pierce, R. D. Nucl. Appl., 4: 47-53(Jan. 1968).

A mutual inductance probe has been developed to determine interface locations between gas and liquid metal and between liquid salt and liquid metal. The probe is a bifilar coil of Nichrome wire on an alumina form contained in a Type 304 stainless steel or ceramic wall. A high-frequency voltage supplied to one winding induces in the second winding a voltage that is related inversely to the depth of liquid surrounding the coil. Probes ~5 and 14 in. long, were calibrated in liquid cadmium, bismuth, and sodium over a temperature range of 200 to 700°C. The device has several important advantages over other means of measuring liquid levels of corrosive fluids at high temperatures. It is compact, rugged, reliable, and reasonably accurate. For a calibrated probe the average deviation in measured liquid level is about 3% of the length of the windings. The instrument is well adapted to operations in remotely operated facilities because it has no moving parts and can be replaced easily. (auth)

8414 FIELD EFFECT TRANSISTOR IN NUCLEAR QUADRUPOLE RESONANCE SPECTROMETERS. O'Konski, C. T.; Cartwright, B. G. (Univ. of California, Berkeley). Rev. Sci. Instrum., 39: 123-4(Jan. 1968).

A super-regenerative circuit employing field-effect transistors was designed and tested for use in nuclear quadrupole resonance spectrometers. The circuit consists of a quenched Colpitts oscillator and drain detector followed by a quench frequency filter and an audio-amplifier. A varactor diode, selected for its high Q, provided for external frequency modulation and for electronic frequency sweep. (B.G.D.)

8415 NANOSECOND RISE TIME, HIGH POWER, VARIABLE DELAY DOUBLE PULSER WITH APPLICATION TO ELECTRON-HOLE PLASMAS. Robbins, William P.; Lantz, Robert M.; Ancker-Johnson, Betsy (Boeing Scientific Research Labs., Seattle). Rev. Sci. Instrum., 39: 69-74(Jan. 1968).

A new double pulse system has been designed and tested which offers several advantages over previous methods of generating and delaying one square wave pulse with respect to another. Characteristics of the new system are: fast rise and fall times (2 nsec typical); high power pulses (150 V into 50 Ω); very low time jitter (less than 0.2% of pulse separation time); accurate repeatability of time delay (±1% typical); extremely wide range of time delay (nanoseconds to milliseconds); dc readout of the time separation of the two pulses accurate to ±1% and suitable for X-Y pen recorders. A special summing junction circuit allows both pulses to be applied to the same load without power being split between the load and the other pulse generator, and also without the first pulse prematurely triggering the second pulse or affecting its amplitude. Some results obtained by applying this system to the study of electron-hole plasma decay are briefly presented. (auth)

8416 COMPARISON OF THE SPHERICAL DEFLECTOR AND THE CYLINDRICAL MIRROR ANALYZERS. Hafner, H.; Simpson, J. Arol; Kuyatt, C. E. (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instrum., 39: 33-5(Jan. 1968).

The calculated performance of electrostatic analyzers of the cylindrical and spherical deflection type are compared. It is shown that considering geometrical terms through the third order the cylindrical device is significantly superior. (auth)

8417 MEDIUM-SENSITIVITY MICROBALANCES FOR MEASURING FORCES EXERTED BY MOLECULAR BEAMS. Marsden, D. G. H. (Princeton Univ., N. J.). Rev. Sci. Instrum., 39: 39-42(Jan. 1968).

Two servo-controlled balances designed to measure forces exerted by molecular beams are described; usable sensitivities are of the order of 10^{-5} dynes. One balance is designed to measure accommodation coefficients on interchangeable targets, which may be heated up to 1000°C. The other, in conjunction with an ion-gauge, may be used to measure absolute molecular beam fluxes and mean incident energies in both single and binary mixed beams. (auth)

8418 USE OF A PHOTOMULTIPLIER AS A PHOTON COUNTER. James, J. F. Mon. Notic. Roy. Astron. Soc., 137: 15-23(1967).

Some experiments with photomultipliers are described, the results of which indicate the optimum conditions of use for the investigation and photometry of very faint light sources by photon counting. (auth)

8419 SIMPLE ARC TRANSCRIBER FOR THE CONSTRUCTION OF ORBITS. Bernhard, Fritz; Schwabe, Stephan (Humboldt-Univ., Berlin). Z. Instrum., 74: 381-3(1966). (In German).

A procedure and device for determining the paths of charged particles were developed. An instrument for the construction of circles with radius between 0.3 m and 25 m is described. The principle of the instrument is described, and application for construction of orbits of charged particles in nontrivial fields is reported. The device constructs arcs without determination of the center of the circle but merely from knowledge of the direction of the desired radius. From this basis it is possible to construct trajectories through equipotential lines, since the trajectory approximates an arc. An illustration demonstrates the construction of orbits for a special rotation-symmetric potential distribution for particles with various initial energies. The exit point predicted by the arc drawer was confirmed experimentally with an apparatus constructed to duplicate the electric fields illustrated. Other uses are suggested as well. (BBB)

8420 MASS SPECTROMETER FOR ULTRA TRACE GAS ANALYSIS. Tsuyama, Hitoshi; Okamoto, Junichi (Hitachi Ltd., Tokyo). Shitsuryo Bunseki, 15: 82-94(June 1967). (In Japanese).

A mass spectrometer for the analysis of ultra trace samples of gases, particularly noble gases, is described. The mass spectrometer is 90°-sector type and its ion trajectory radius is 200 mm. Its main parts are made of stainless steel. The vacuum system is extremely clean and easily maintainable. The evacuating system includes a molecular pump or a 3'' oil diffusion pump. By 48 hours evacuation and thorough bakeout, the ultimate pressure of the analyzer in the order of 10^{-9} mmHg is attainable. The instrument may be operated in the static mode and the detailed procedure is described. The incremental characteristics of background peaks and the diffused peak of argon at $M_A = 80$ were investigated. Fission product isotopic rare gases and isotopic ratios of uranium were determined. (auth)

8421 SHAPED COLLIMATORS IMPROVE ONE-SHOT VOID DETECTORS. Lottes, Paul A. Power Reactor Technol. Reactor Fuel Process., 10: 148-9(Spring 1967).

The ingenious application of old principles of void-measurement techniques with gamma rays has produced an accurate new device that simplifies void measurements in small flow channels. The device, a shaped collimator for one-shot void detectors which minimizes the dependence of the measurements on the void distribution in the flow channel, is described. (auth)

8422 CALIBRATION OF HALL TRANSDUCERS BY MEANS OF A NUTATION MAGNETOMETER. Bersenev, P. A.; Meshcherov, R. A.; Stakhov, O. V. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 9-12(July-Aug. 1967). (In Russian).

The use of a NMR magnetometer based on the phenomenon of nutation for the calibration of Hall transducers was described and the method of calibration was given. It was shown that by means of a nutation magnetometer this operation can be done more simply with high precision in a wide range of the magnetic field. In the device described, the calibration of the transducers was done in the range from 5 to 25 koersted without replacement of the measurement transducer and in heterogeneity of the field from 3 to 5×10^{-4} cm^{-1}. The error in the measurement of the field by means of a nutation magnetometer was $\sim 2 \times 10^{-5}$. The total error of the calibration, caused by the temperature changes of the EDS, change of the supply current etc., does not exceed 2 to 4×10^{-4}. (tr-auth)

8423 THE NEW ZEALAND ATOMIC CLOCK. Gerard, V. B. (Physics and Engineering Lab., Lower Hutt, N. Z.). N. Z. Sci. Rev., 23: 89-90(1965).

A description of the New Zealand atomic clock which uses rubidium is presented. The clock does not vary by more than about a second in 1000 years. (W.H.K.)

8424 CONVERSION OF A GRID-DIP METER INTO A VARIABLE FREQUENCY NMR SPECTROMETER. Rubinstein, M. (Naval Research Lab., Washington, D. C.); Shtrikman, S. Amer. J. Phys., 35: 945-8(Oct. 1967).

A variable-frequency NMR spectrometer, constructed from a commercial grid dip meter, is described. The spectrometer is exceedingly simple to construct. It may be operated in either the marginal or the super-regenerative mode. Although applications to magnetically ordered materials are stressed, the spectrometer can be used to detect nuclear magnetic and nuclear quadrupole resonances in nonmagnetic substances as well. (auth)

8425 ION MICROPROBE MASS ANALYZER. Liebl, Helmut (Hasler Research Center, Goleta, Calif.). J. Appl. Phys., 38: 5277-83(Dec. 1967).

The development of an instrument is described which is analogous to an electron microprobe x-ray analyzer, whereby the electron microprobe is replaced by an ion microprobe, and the x-ray spectrometer by a mass spectrometer. A duoplasmatron is the primary ion source. The primary ion beam is mass separated to eliminate impurity ions. A probe diameter of less than 2μ at 2×10^{-10} A is realized for 12-kV Ar^+ ions. A new mass spectrometer was developed with the emphasis on high transmission, yet simple construction. It is stigmatic imaging, double focusing, has a mass-resolving power of 300 with a solid acceptance angle of 1.5×10^{-2} sr (4° half-angle) and a transmitted-energy bandwidth of 10%. It consists of an axially symmetrical electrostatic Einzel lens, a 45° spherical condenser sector, and a magnetic field with plane but inclined pole faces, which deflects the beam by 90°. No entrance slit is used. Experimental results are presented. (auth)

8426 APPARATUS FOR WEIGHING SOLID SAMPLES IN AIR AND IN A LIQUID. Brebant, Charles (to Commissariat a l'Energie Atomique). British Patent 1,095,128. Dec. 13, 1967. Priority date Aug. 18, 1964, France.

The design of a remote controlled densimeter for weighing solid samples in air and in a liquid is presented. Deaeration is accomplished by ultrasonics when the sample is weighed in a liquid. (W.H.K.)

8427 DEVICE FOR ASCERTAINING THE POSITION OF RADIATION SOURCE. Imai, Takeshi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-19760. Sept. 16, 1966. Filed Dec. 2, 1963.

A device for ascertaining the containment of a radiation source in its container is described. The source is for nondestructive tests with radiation. In such containers, the source is usually taken into or pushed out of its container by means of the connection of a source, a solid handling wire, a soldered joint, and a handling wire, in order; when the source is in its sure containment, a lamp is lighted by the switch closed by the contact of the joint. In this case, however, the breakage of any part of the connection damages the indication of its containment. In the proposed method this indication is achieved by several steps of motion of the source in and out of its container. The result is sure indication of the containment of a source in its container. As is usual, the passageway for a radiation source runs through the container, and the connection of the source etc. is the already-described one. At the entrance and exit of the passageway are installed switches that are opened or closed by the soldered contact to them by the source holder or joint. The containment-indication lamp is lighted by means of a switch, closed only after the closing of a set of switch devices. (NSA of Japan)

Radiation Effects on Instruments and Instrument Components

8428 (CONF-670708-4) SOME ASPECTS ON THE THEORY OF TRANSIENT RADIATION INDUCED DIFFUSION CURRENTS IN SEMICONDUCTOR DIODES. Sigfridsson, B.; Leman, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Oct. 1967. 17p. Dep.

From Nuclear and Space Radiation Effects Conference, Columbus, Ohio.

Analytical expressions for the shape of the diffusion component of the current pulses from a reverse-biased semiconductor diode irradiated by short bursts of x rays are derived, taking into account the physical dimensions and the effect of back diffusion of charge carriers into the bulk regions from the depletion zone. By the model used it seems to be possible to explain the experimentally observed variations of both the amplitude and the decay of the diffusion component with the reverse voltage. (auth)

8429 AN APPROACH TO RADIATION EFFECTS IN MOS DEVICES. Holmes-Siedle, A. G.; Zaininger, K. H. (RCA Labs., Princeton, N. J.). RCA Eng., 13: 55-9(Aug.-Sept. 1967).

The effect of ionizing radiations on MOS (metal-oxide-semiconductor) transistors is surveyed. When an MIS (metal-insulator-semiconductor) device, such as the MOS transistor, is exposed to nuclear or space radiation, the principal effect is not strictly a degradation as is the case in solar cells or bipolar transistors. Instead, the MIS transistor undergoes a change of operating region, which is in the nature of a shift in the bias-dependent characteristics of the device. Other less significant changes include variations in the shape of the characteristic curve and increased leakage current; both of these effects are effectively degradations. The mechanisms involved in radiation damage in MIS devices apply widely to the mass-produced MOS devices now available. Marked improvement is expected in radiation hardness of MOS devices from development of process techniques which reduce hole-trap concentration in the oxide. The physics of these effects in MIS devices, the known radiation data, and methods of reducing the effects of radiation on the device are discussed. (BBB)

8430 SUSCEPTIBILITY OF MOS TRANSISTORS TO DAMAGE FROM GAMMA RADIATION. Philipp, L. D. (Pacific-Northwest, Richland, Wash.); Lauritzen, P. O. Trend Eng. Univ. Wash., 19: No. 4, 13-14; 20-2(Oct. 1967). (BNWL-SA-1399).

Metal-oxide-semiconductor (MOS) transistors are especially susceptible to degradation when operated in an ionizing radiation environment. During irradiation a positive charge builds up in the surface oxide layer, and surface states are introduced that cause large changes in the operating characteristics of the device. Irradiation of 33 devices with ^{60}Co demonstrated that a factor-of-10 improvement in radiation resistance can be obtained by using optimum-device types (n-channel) at gate voltages that minimize threshold voltage shifts (approx. zero volts). A tendency for the devices to turn off gradually at high doses was also observed. (auth)

8431 IMPROVEMENTS IN SEMICONDUCTOR TRANSISTORS. Price, John Clifford (to Standard Telephones and Cables Ltd.). British Patent 1,095,747. Dec. 20, 1967. Filed Dec. 1, 1966.

Fabrication of a semiconductor transistor which has a reduced susceptibility to radiation-induced deterioration is described. It consists of a silicon transistor which contains lithium as a dopant in the base region in addition to the conductivity-type determining dopant which is of an element other than lithium. (W.H.K.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 8502, 8532, 8538, 8543, 8549, 8569, 8571, 8588, 8589, 8592, 8665, 8669, 8675, and 8684.

8432 (BNL-11831) ^{99m}Tc LABELED COMPOUNDS. Richards, P.; Atkins, H. L. (Brookhaven National Lab., Upton, N. Y.). Oct. 12, 1967. 19p. (CONF-671113-1). Dep. CFSTI.

From 7th Annual Meeting on Nuclear Medical Society, Tokyo, Japan.

The radioisotope ^{99m}Tc has played an important role in the rapid growth of nuclear medicine owing to its combination of excellent physical characteristics and its ready availability from the ^{99}Mo–^{99m}Tc generator. The development of compounds labeled with ^{99}Tc having different biological distributions has greatly increased its usefulness and made it the isotope of choice for several applications. A detailed study of the chemistry involved in labeling human serum albumin with technetium resulted in the development of a reproducible method for labeling with high efficiency and the production of a product of high specific activity. As a result of these studies a new compound, ^{99m}Tc–DTPA, was prepared that may further enhance the usefulness of the isotope in nuclear medicine. (auth)

8433 (CONF-670305–, pp 30-44) EFFECTS OF ACCELERATED HEAVY IONS ON ENZYMES IN THE DRY STATE AND IN AQUEOUS SOLUTIONS. Brustad, Tor (Norsk Hydro's Inst. for Cancer Research, Oslo).

A brief review of the mechanisms of heavy-ion-induced injuries to enzymes in dilute aqueous solutions and in the dry state is presented. The effectiveness of cysteine, ethanol, glycerol, or histidine in reducing the degree of enzyme inactivation is discussed. (B.H.S.)

8434 (CONF-670305–, pp 197-220) PHYSICAL, GEOMETRICAL, AND TEMPORAL FACTORS DETERMINING BIOLOGICAL RESPONSE TO HEAVY CHARGED PARTICLES. Sondhaus, Charles A. (California Coll. of Medicine, Irvine).

The biological response to radiation depends both on absorbed dose and dose distribution within tissue. In the case of high-energy charged particles several physical measurements are required to specify the dose distribution. The complete characterization of an exposure requires identification of: the accumulated absorbed dose; the dose rate over a period of time; the region of the body exposed; the depth-dose distribution; and the LET. (E.R.B.)

8435 (CONF-670305–, pp 241-54) ELECTRON FLUX SPECTRA IN ALUMINUM: ANALYSIS FOR LET SPECTRA AND EXCITATION AND IONIZATION YIELDS. Birkhoff, R. D.; McConnell, W. J.; Hamm, R. N.; Ritchie, R. H. (Oak Ridge National Lab.). (ORNL-P-2916).

Measurements were made of the electron flux generated in effectively infinite Al media by uniformly distributed sources of ^{198}Au and ^{64}Cu. Above 100 keV the shapes of the flux are determined by the integral primary beta spectrum. Between 100 keV and 5 keV the flux is constant. Between 5 keV and 100 eV the flux rises as 1/E and below 100 eV rises as about $1/E^3$. On an absolute basis the experiment is in agreement with the Spencer–Fano theory above 10 keV but exceeds the theory by as much as a factor of 4 to 400 eV. The results were analyzed to obtain LET spectra as well as K-shell and L-shell ionization, volume plasmon excitation, and electron-electron interaction yields. The conclusions drawn from the analysis were that electrons with energies less than 55 eV contribute as much to the flux in LET space as do electrons with energies greater than 55 eV, that electrons are nearly mono-LET particles, and that volume plasmon excitation accounts for nearly all of the energy delivered to an aluminum medium by an electron slowing down in it. (auth)

8436 (NYO-910-58) I. RADIATION MECHANISMS IN MAMMALIAN SYSTEMS. II. CHEMICAL SENSITIZATION TO RADIATION LETHALITY. Progress Report, May 1, 1966–May 1, 1967. Laughlin, John S.; Kim, Jae Ho; Moroson, Harold (Sloan-Kettering Inst. for Cancer Research, New York). Aug. 15, 1967. Contract AT(30-1)-910. 20p. Dep. CFSTI.

X RADIATION—effects on protein and RNA synthesis by synchronous HeLa and human leukemic cells, tracer study of
CELLS, HeLa—radiosensitivity of, effects of acetoxycyclohexamide, hydroxyurea, and phleomycin on x
ELECTRON BEAMS—effects on HeLa cells, RBE for (B.H.S.)

8437 THROMBOPLASTIN ACTIVITY OF VARIOUS LAYERS OF THE VASCULAR WALL IN RADIATION SICKNESS. Andrushko, I. A. (Kazan State Medical Inst., USSR). Byull. Eksp. Biol. Med., 63: No. 5: 29-32(May 1967). (In Russian).

The thromboplastin activity of various layers of the vascular wall and interrelations of tissue and blood coagulation factors in the radiation hemorrhagic syndrome were studied in 40 rabbits. In the development of the hemorrhagic syndrome the thromboplastin activity of the aorta intimae and bone marrow diminishes; the thromboplastin activity of other parts of the aorta and brain does not change and that of the spleen rises. (auth)

8438 EFFECT OF COMPLEX COBALT COMPOUNDS ON THE PROCESS OF MUSCLE TISSUE REGENERATION IN IRRADIATED ANIMALS. Seifullin, F. Kh. (Inst. of Roentgenology, Radiology, and Oncology, Tashkent). Byull. Eksp. Biol. Med., 63: No. 5, 93-7(May 1967). (In Russian).

Experiments were carried out on 150 white male rats, that had undergone one-step whole-body irradiation at doses of 800 R. On the 5th day after irradiation, in aseptic conditions, a transverse incision of biceps was made with a razor blade at the level of the middle third of the femur with subsequent thin capron suture. After incision the experimental animals were treated with coamide, Co-8, Co-9 and Co-30, that were injected in the muscle daily, 2 to 3 mg per kg of body weight for 20 to 25 days. Observations showed that the process of regeneration of the somatic muscle tissue in irradiated rats was delayed. The use of the above preparations of cobalt tracer element compounds considerably hastens the process of muscle trauma regeneration in irradiated animals. (auth)

8439 EXPERIMENTAL AMYLOIDOSIS IN ISOGENEIC X-IRRADIATED RECIPIENTS OF SENSITIZED SPLEEN TISSUE. Hultgren, Myron K.; Druet, Robert L.; Janigan, David T. (Univ. of Kansas, Kansas City). Amer. J. Pathol., 50: 943-55(June 1967).

Spleen cells or fragments from normal donor mice or from donors previously sensitized by multiple injections of a soluble protein antigen, azocasein, were injected intraperitoneally into lethally irradiated, isogeneic recipients. At the time of transfer, no amyloid was found in the donor spleens. After transfer the recipients were given injections of azocasein. Amyloidosis developed only in the recipients of sensitized donor cells, and it occurred after a period of injections that was distinctly shorter than that required for amyloid induction in normal, intact mice. The results show that the sensitized lymphoreticular cell population of the donor played an indispensable and limiting role in amyloid induction in the recipient. The distribution and severity of amyloid in the irradiated recipients differed in many respects from those usually found in intact mice given the same antigen injections. These differences were noted in organs and structures distributed along the routes of lymphatic and portal-venous drainage of the peritoneal cavity the site of donor spleen injections. The location of amyloid deposits in these organs was, however, related to the usual distribution of the reticuloendothelial cells of the recipient. On the basis of the recorded findings, it is proposed that amyloidosis results from an interplay of sensitized donor cells and the reticuloendothelial cells of the recipient, with the latter determining the ultimate location of the amyloid deposits. (auth)

8440 SOME RESULTS OF ANALYSIS OF THE E.P.R. SPECTRA OF WHEAT GERM IRRADIATED IN ANOXIC CONDITIONS. Dobretsova, T. B.; Anufrienko, V. F. (Inst. of Cytology and Genetics, Novosibirsk, USSR. Inst. of Catalysis, Novosibirsk, USSR). Biophysics (USSR) (Engl. Transl.), 11: 1239-41(1966).

Translated from Biofizika, 11: 1082-4(1966).

Samples of wheat germ with a moisture content of 6% were x-irradiated to an integral dose of 500 kR at a dose rate of 5 kR/min. in special evacuated U-shaped quartz ampoules. The electron paramagnetic resonance (EPR) spectra were recorded with widths of 30, 19, and 9 oersteds, respectively. Each of the lines was assumed to correspond to one of the three classes of radicals. As oxygen was admittted to the ampoule, the widest spectral line vanished. Therefore, the formation of peroxide radicals from free radicals was postulated. The increase of intensity of the other two spectral lines as oxygen was added to the ampoule led to their identification as paramagnetic products of the RO_2^* type. It was concluded that: free radicals in irradiated plant seeds appear as a result of interaction of the centers of primary damage with the surrounding molecules, the number of free radicals capable of interaction with oxygen increased with dose, and observed free radicals being induced by irradiation in the presence of oxygen. (E.R.B.)

8441 MEASUREMENT OF NUCLEOTIDE, AMINO ACID, AND DNA CONTENTS OF TISSUES AFTER WHOLE-BODY X-IRRADIATION. Burger, Charles L. (State Univ. of New York, Syracuse). Anal. Biochem., 20: 373-86(Sept. 1967).

An automated method for the separation of artificial mixtures of nucleotides was applied to the more difficult problem of obtaining quantitative and qualitative measurements on biologically occurring nucleotides in complex tissues. These data may be correlated with changes in amino acid and DNA contents following whole-body x-ray exposure to intense doses of 2000 R. Results indicate that the techniques utilized may be useful in determining the early effects of absorbed energy in tissues. Liver, gut, and thymus from rats were used to compare radiation-resistant with radiation-sensitive tissues. (auth)

8442 STUDIES OF THE EFFECT OF IRRADIATION OF CELLULAR PARTICULATES. IV. COMPARISON OF UNCOUPLING AT THE THREE PHOSPHORYLATING SITES. Yost, Henry T.; Yost, Martha T.; Robson, Hope H. (Amherst Coll., Mass.). Biol. Bull., 33: 697-702(Dec. 1967).

White male rats of Sprague-Dawley strain were exposed to 1000 R whole-body γ irradiation. Measurements of the uncoupling at each of the three phosphorylating sites in mitochondria isolated from liver and spleen were made. The results indicate that the terminal step (oxidation of reduced cytochrome-c) is the most sensitive of the three and that the great majority, if not all, of the observed uncoupling may result from damage to this step. (auth)

8443 PROPERTIES OF PENICILLINASE FROM BAC, LICHENIFORMIS AFTER TREATMENT WITH γ-RAYS OF ^{60}Co. Mogilevchik, L. E.; Weis, R. A.; Chaikovskaya, S. M.; Tebyakina, A. E.; Sazykin, Yu. O.; Khrushchev, V. G. (All-Union Scientific Research Inst. of Antibiotics, Moscow). Antibiotiki, 12: 673-6 (Aug. 1967). (In Russian).

Highly purified penicillinase (3,000,000 units/mg of protein) from *Bacillus licheniformis* preserved unchanged its fermentative activity, as well as its pharmacologic properties after irradiation with γ rays of radioactive cobalt in a dose of 2.5 million RAD. This dose provided sterility of the enzyme preparation. (auth)

8444 REDUCTION OF STRONTIUM ABSORPTION IN MAN BY THE ADDITION OF ALGINATE TO THE DIET. Sutton, A. (Medical Research Council, Harwell, Eng.). Nature (London), 216: 1005-7(Dec. 9, 1967).

In a search for a non-toxic substance which will reduce the intestinal absorption of radio-strontium, without interfering with calcium absorption, it was found that sodium alginate, extracted from seaweed, approaches these requirements. This substance consists of a mixed polymer of l-guluronic and d-mannuronic acids. The effectiveness of sodium alginate in reducing strontium absorption in both man and laboratory animals has received considerable study, but due to the variability in composition of the alginates used, comparison of results has been difficult. An alginate derivative with a guluronic/mannuronic ratio of 97% was prepared and compared with the commercial preparation Manucol SS/LD having a G/M ratio of 71%, added to a milk-only diet of man. Strontium-87m (half-life 2.8 hours) was used for the tests. Blood plasma was collected for counting 2 hours after administration of the radio-strontium plus alginate. Urine was collected for counting 7 hours after ingestion. The calcium contents of the milk and urine were measured by flame photometry. Results are tabulated. The lowest concentrations of ^{87m}Sr in both plasma and urine were found in subjects who received the 97% G/M alginate, rather than the 71% G/M material. There was some reduction in urinary calcium in most cases, but results for calcium were inconclusive. (UK)

8445 PHOTOREACTIVATION IN VIVO OF PYRIMIDINE DIMERS IN PARAMECIUM DNA. Sutherland, B. M.; Carrier, W. L.; Setlow, R. B. (Oak Ridge National Lab., Tenn.). Science, 158: 1699-1700(Dec. 29, 1967). (ORNL-P-3367).

Cells of *Paramecium aurelia* labeled with tritium-labeled thymidine were irradiated with ultraviolet light and then were either exposed to photoreactivating light or kept in the dark as controls. In the controls, the level of thymine-containing pyrimidine dimers did not change, but in cells exposed to photoreactivating light such dimers were destroyed. This is the first demonstration in a eukaryote of in vivo photoreactivation of thymine-containing pyrimidine dimers. (auth)

8446 SUPPRESSION OF THE IMMUNE RESPONSE TO ANTIGENIC TUMORS IN ISOGENIC MICE BY WHOLE-BODY IRRADIATION. Rosenau, Werner; Moon, Henry D. (Univ. of California, San Francisco). Cancer Res., 27: 1973-81(Nov.1967).

It is known that sarcomas induced in mice with 3-methylcholanthrene (MCA) bear tumor-specific antigens that evoke specific immune responses when transplanted to isogenic animals. In this study, MCA-induced sarcomas were transplanted to isogenic C3H mice and the effect of immune suppression by whole-body x irradiation on tumor growth was examined. The role of radiation dose, interval between irradiation and transplantation, and age was evaluated in animals irradiated before transplantation. The results obtained in animals irradiated before transplantation were compared with those in animals irradiated after transplantation. (E.R.B.)

8447 THE CONCENTRATION IN TUMOR AND OTHER TISSUES OF PARENTERALLY ADMINISTERED TRITIUM- AND ^{14}C-LABELED TETRAPHENYLPORPHINESULFONATE. Winkelman, James; Slater, Gary; Grossman, Judith (New York Univ. School of Medicine). Cancer Res., 27: 2060-4 (Nov. 1967).

Tritium- and ^{14}C-labeled tetraphenylporphinesulfonates (TTPS) were synthesized, purified, and characterized. The distribution of radioactivity and of the intact TPPS molecule was determined after injection of each compound into rats bearing the Walker carcinosarcoma. Intact TPPS accumulated in higher concentration in the tumor than in other tissues. The relative tissue concentrations of ^{14}C administered as TPPS-^{14}C was similar to that of intact TPPS. The tissue distribution of tritium, administered as TPPS-^{3}H, was entirely different from both TPPS and ^{14}C. The indissociably bound ^{14}C attained sufficiently high relative concentrations in kidney and liver to preclude its use as a tumoricidal agent. The observed tumor: tissue concentration ratios for all organs is sufficient for tumor localization by external scintillation scanning if an α-emitting isotope is similarly bound to TPPS. (auth)

8448 STABILITY OF VITAMIN D IN THE UV-IRRADIATED YEASTS SACCHAROMYCES CEREVISIAE AND TORULA UTILIS IN COMPARISON WITH UV-IRRADIATED SKIN AND WITH D-HYDROSOLES. Bekemeier, H.; String, H. (Martin-Luther-Univ., Halle-Wittenberg, Ger.). Pharmazie, 19: 608-10(Sept. 1964). (In German).

Saccharomyces cerevisiae and *Torula utilis* yeast samples were exposed to uv irradiation at room temperatures in their antirachitic effects on rats studied at various times over an interval of eight yr. *Saccharomyces cerevisiae* retained ~20% of its original effectiveness at the end of the eight yr period. Its effectiveness decreased with a half time of ~30 months. After six yr *Torula utilis* still remained ~30% of its initial effectiveness, also corresponding to a half time of ~30 months. The stability of the yeast vitamin D was similar to vitamin D solutions in oil, and better than vitamin D in detergent solutions. The activity loss coefficients of the detergent solutions were ~10 times greater than those of the uv-treated yeast. Stability of vitamin D in uv-irradiated animal skin was almost as good as in the yeasts studied. The high stability of the vitamin D in the uv-irradiated yeast may have resulted from the presence of cholesterol and the exclusion of atmospheric oxygen. The data obtained provide a basis for estimating the vitamin D content and the antirachitic effectiveness of uv-irradiated *Saccharomyces cerevisiae* and *Torula utilis*. (BBB)

8449 PHOTOREACTIONS IN A NUCLEAR PART IRRADIATED WITH AN ULTRAVIOLET MICROBEAM IN INTERPHASE CELLS DERIVED FROM VARIOUS SPECIES. Naruse, Sensuke; Yatani, Ryuichi; Takeda, Susumu (Mie Prefectural Univ., Tsu, Japan). Mie Med. J., 16: 193-205(Jan. 1967).

Morphological and cytochemical changes at nuclear sites exposed to uv microbeam irradiation in living cells from different species were examined by phase microscopy, uv microscopy, microspectrography, and the Feulgen staining method for DNA. The results indicated that the uv-induced reactions in these cells could be divided into three types on the basis of phase microscopic and DNA changes. In the first type the irradiated part of the nucleus was seen as a pale and DNA-deficient area, in newt peritoneal leukocytes and grasshopper spermatocytes. In the second kind of reaction the uv-exposed part was observed as a dark and DNA-rich area, in two kinds of cultured human cells, cultured chick embryonal fibroblasts, and two kinds of animal ascites tumor cells. The third reaction was shown by human blood monocytes; phase-contrast of the exposed part changed from pale to dark proportionally with the irradiation dose, but the DNA content decreased. These changes were reproduced in model experiments with extracted deoxynucleoprotein and DNA in vitro. However, mechanisms accounting for the difference in these types remain obscure. (BBB)

8450 ON MECHANISM OF STRONTIUM DEPOSITION IN BONE TISSUE. Berger, H. J.; Eger, W. (Univ., Goettingen, Ger.). Acta Histochem., 22: 298-308(Dec. 24, 1965). (In German).

In vitro studies were made on Sr uptake by rat femur. The bone was fixed in formalin and decalcified electrolytically in dilute nitric acid. Frozen sections were also studied. The sections were incubated at room temperature in $SrCl_2$ solutions at concentrations of 0.1, 0.01, and 0.001 M for 1 hr. The Sr uptake was demonstrated by Na N,N-naphthylhydroxylamine and by Na rhodizonate in aqueous solutions. Strontium was accumulated mainly in areas rich in mucopolysaccharides, and the maximum level was reached in a few minutes. The ion-exchange properties of mucopolysaccharides are presumably responsible for the observed Sr uptake of bone. When decalciifed bone was incubated in solutions containing both Ca and Sr ions, more Sr than Ca was taken up by bone. Strontium was selectively accumulated in the cartilage of the epiphysis and the growth zone; little Sr was taken up in the bone spicules of the metaphysis. More Sr was deposited in bone from solutions of higher than lower Sr concentration. (BBB)

8451 ^{99m}Tc IN THE SCANNING OF THE STOMACH. Bartelink, A.; Woldring, M. G.; Hoedemaeker, Ph. J.; Abels, J. (Univ. Hospital, Groningen, Netherlands). Lancet, 2: 420(Aug. 19, 1967).

Pertechnetate-99m ($^{99m}TcO_4$) accumulation in the gastric wall and its excretion in the gastric juice in rats were studied. In a clinical study, correlations were made of radioisotope scans of the stomach area with the functional and anatomical properties of the gastric mucosa. In normal persons the scan showed the size and position of the whole stomach. Of 20 patients with pernicious anemia, known to have atrophic gastritis, 13 had normal and seven had abnormal scans. All seven abnormal scans, characterized by the absence of contrast in the body area or in the pyloric antrum or both, were always accompanied by striking intestinal metaplasia in the corresponding parts of the gastric mucosa. Apparently, disappearance of the normal mucosa and its replacement by intestinal-type surface epithelium interferes with the excretion of $^{99m}TcO_4$. The same feature was found in patients with peptic ulcer. The metabolism of pertechnetate has no cellular linkage with the excretion of hydrochloric acid, intrinsic factor, or pepsin, so that it may be used as an additional test of stomach function. (BBB)

8452 ABERRANT CORNEAL EPITHELIAL CELLS PRODUCED BY RUBY LASER IRRADIATION. Parr, W. H.; Fisher, Robert S. (Army Medical Research Lab., Fort Knox, Ky.). Invest. Ophthalmol., 6: 356-63(Aug. 1967).

Mitotic indices and aberrant figures seen in the corneal epithelium of rats following ruby laser irradiation are described and their possible significance discussed. After doses of 4 J/cm^2, aberrant corneal epithelial cells became apparent immediately after laser irradiation and some were still present 30 days later. At 8 J/cm^2 twice as many, or more, atypical cells were found. These cells showed different types of aberrations. Some exhibited a distortion of nuclear material so that the center of the cell was filled with a dense mass of clumped chromatin. Other cells had an unequal separation of chromosomes at anaphase and telophase, while still another group displayed a persistent chromosomal bridge at these same phases. Lagging chromosomes, because of mechanical breaking of the chromosomal bridges, were seen in some cells. The difference in mitotic index between the lasered corneas and their contralateral controls was not significant. Exposure at 8 J/cm^2 decreased the numbers of cells in prophase, metaphase, and anaphase. At one-half this dose only a decrease in the number of cells in prophase and metaphase was seen. The mechanism by which laser radiation alters the cornea remains obscure. (BBB)

8453 A SIMPLIFIED METHOD OF PRODUCING ALBUMIN AGGREGATES LABELED WITH ^{99}Tc FOR USES IN LUNGS SCINTIGRAPHY. Charamza, O.; Budikova, M.; Wiedermann, M. Isotopenpraxis, 3: 419-20(1967). (In German).

A simplified method of producing albumin aggregates labeled with ^{99m}Tc for uses in lung scintigraphy is described. (auth)

8454 ENZYMATIC CHANGES IN BETA-IRRADIATED EPIDERMIS OF GUINEA PIGS: ACID AND ALKALINE PHOSPHATASES AND INORGANIC PYROPHOSPHATASES. Tabachnick, Joseph; Perlish, Jerome S.; Chang, Lan Fen; Freed, Richard M. (Albert Einstein Medical Center, Philadelphia). Radiat. Res., 32: 293-308(1967).

After a single skin surface dose of 3000 rep of β-irradiation from a ^{90}Sr$-^{90}$Y sealed source, epidermis of albino guinea pigs was excised and washed in 0.9% NaCl (extracellular fraction), and the washed tissue was homogenized in saline (intracellular fraction). The time course of changes in acid phosphatase, alkaline 5′-nucleotidase (AMPase), and inorganic pyrophosphatase was followed. The earliest increase in intracellular acid phosphatase was detected about six days postirradiation, after pyknosis. Histochemical localization revealed minute acid phosphatase-rich granules primarily in the cells of the stratum granulosum. These increased in size and number in the cells of the hyperplastic epidermis 30 days postirradiation when the peak increases in extra and intercellular acid phosphatase occurred. Treatment with Triton X-100 resulted in diffuse staining without granule formation, suggesting that these granules may be lysosomes. There was a progressive decrease in extra and intracellular alkaline AMPase and inorganic pyrophosphatase to 20% and 50% of the control, respectively, by the tenth day, and it remained at this lower level to the sixtieth day. These decreases reflect a decrease in enzyme per cell and cell number up to about the tenth day, as well as an increase in protein content beginning about the sixth day. Epidermal alkaline AMPase is present in all nonirradiated cells, but regenerated hyperplastic epidermis 30 days postirradiation showed activity principally confined to basal layer cells. (auth)

8455 COMPARATIVE UPTAKE AND ELUTION OF ^{45}Ca, ^{85}Sr, ^{133}Ba, AND ^{223}Ra IN BONE POWDER. Harrison, G. E.; Howells, G. R.; Pollard, J. (Medical Research Council, Harwell, Eng.). Calcified Tissue Res., 1: 105-13(1967).

The rapid rates of uptake and elution of these radionuclides were studied in powdered rat bone under controlled conditions. A solution whose inorganic composition closely resembled that of extracellular fluid was passed through a bone column at a constant flow rate and constant pH. The concentrations of the major inorganic components and of Sr in the solution remained unchanged in passing through the bone powder. Rates of increase and removal of the four nuclides from the bone were then determined and these were fitted by exponential expressions consisting of two terms. By integration of these expressions, space constants were derived for each of these nuclides in the bone powder. Two rate processes were identified. The first one was completely reversible for both ^{45}Ca and ^{85}Sr when elution followed immediately after the uptake but was almost absent in the case of ^{133}Ba and ^{223}Ra. The size of the second space constant was dependent on the time delay in carrying out the elutions of activity from the bone. The overall result, namely an increased retention of the heavy elements in bone, was not expected. (BBB) (TSS)

8456 EFFECT OF DEUTERIUM OXIDE ON THE SAPROPHYTIC CULTURE OF CLAVICEPS. II. ALKALOID PRODUCTION. Mrtek, R. G. (Univ. of Illinois, Chicago); Crespi, H. L.; Blake, M. I.; Katz, J. J. J. Pharm. Sci., 56: 1234-8(Oct. 1967).

In high concentrations of D_2O the formation of alkaloids by this mold was found to be impaired. Consequently, a replacement culture technique was used to induce the elaboration of deuterium-labeled alkaloids from water-grown fungal tissue that was resuspended in a medium containing more than 98% D_2O. Cultures grown in an ordinary H environment were transferred to a deuterium-labeled medium containing various substrates such as tryptophan, mevalonic acid, phenylalanine, succinic acid, and sugars, either as H or D compounds. Multimilligram amounts of alkaloids were obtained from replacement cultures containing phenylalanine and deuterio-succinic acid as substrates. The alkaloid fraction, consisting of elymoclavine with minor amounts of agroclavine, was isolated by solvent extraction. The alkaloids were identified by thin-layer chromatography, and the incorporation of deuterium-labeled substrate into the alkaloids by the replacement culture technique was verified by NMR spectroscopy. (BBB)

8457 EFFECT OF IRRADIATION IN VITRO ON MITOCHONDRIAL METABOLISM: OXIDATION OF CITRIC ACID CYCLE SUBSTRATES. Clark, J. B. (Medical Coll. of St. Bartholomew's Hospital, London). Eur. J. Biochem., 2: 19-25 (July 1967).

Some metabolic parameters were measured in rat liver mitochondria oxidizing several citric acid cycle substrates after in vitro exposure to doses of ionizing radiation up to 100 Krad. With the substrates β-hydroxybutyrate, succinate, α-oxoglutarate, pyruvate, glutamate, and isocitrate the P/O (P/2e) ratio and the respiratory control, as well as the various mitochondrial respiratory states, were examined with the oxygen electrode. The P/O ratios of mitochondria oxidizing β-hydroxybutyrate and succinate fell by 10% after a 100 KRAD dose. After the same dose the P/O ratio with glutamate or pyruvate fell by 20%, with α-oxoglutarate 25%, and with isocitrate 30%. In all cases except with isocitrate, the respiratory control fell more sharply than the P/O ratio after irradiation. After the 100-KRAD dose the respiratory control of mitochondria oxidizing succinate fell by 20%, isocitrate by 30%, pyruvate or glutamate by 34%, β-hydroxybutyrate by 37%, and α-oxoglutarate by 42%. (BBB)

8458 REDUCTION OF THYROID IRRADIATION FROM ^{131}I BY POTASSIUM IODIDE. Blum, Manfred; Eisenbud, Merril

(New York Univ., N. Y.). J. Amer. Med. Ass., 200: 1036-40 (June 19, 1967).

The efficacy of KI in suppressing thyroid ^{131}I uptake was investigated as a means of reducing the risk of thyroid damage due to a single, massive exposure to this isotope. Human exposure is possible as a result of the industrial, medical, or research use of ^{131}I and could be particularly significant following reactor or fuel processing plant accidents. Thyroid ^{131}I uptake was measured in 62 healthy volunteers 24 hr after the administration of a standard dose of 1.5 nCi ^{131}I. Doses of KI (5 to 1000 mg) were given 1 hr before or various intervals after radioiodine. It was shown that the prophylactic administration of 100 to 200 mg of KI in anticipation of radioiodine exposure will largely prevent uptake by the thyroid gland, thereby reducing the irradiation dose delivered by more than 98%. The same amount given at intervals after ^{131}I absorption was progressively less effective, but still reduced uptake to less than half after a delay of 3 hr. The suppressive effect of one dose was of short duration and daily readministration of the agent was required for prolonged protection. The extent of uptake blockade could be estimated by measuring serum inorganic iodide; concentrations of greater than 10 μg/100 ml correlated with marked uptake arrest. Toxicity of KI was negligible for a single ingestion, but it must be avoided by those allergic to it. (BBB)

8459 POLONIUM IN TOBACCO. Droessmar, F. Naturwiss. Rundsch., 20: 338(Aug. 1967). (In German).

At the temperature range of 890 to 920°C produced by burning cigarette tobacco, the ^{210}Po it contains is vaporized and may be inhaled in the smoke. The ^{210}Po content of cigarette tobacco varies considerably with the locality in which it is grown. Rhodesian tobacco contains 0.67 to 0.84 pCi/g, New Zealand tobacco 0.15 pCi/g, and the average for tobacco from South Africa and the southern U.S. is 0.49 pCi/g. The ^{210}Po concentration in rib bone ash of smokers is about 0.25 pCi/g, with a ^{210}Pb concentration of 0.285 pCi/g. For nonsmokers these values are lower, being 0.09 pCi/g for ^{210}Po and 0.135 pCi/g for ^{210}Pb. The lung concentrations of these elements is approximately 100% greater in smokers than in nonsmokers. Concentrations as low as 0.3 pCi/kg blood can be measured after separation with HCl and ascorbic acid. (BBB)

8460 RELATION BETWEEN RADIOIODINE ACCUMULATION AND FOLLICULAR SIZE IN THE THYROID OF THE GUINEA PIG. Trolldenier, H.; Worseck, M. (Institut fuer Vergleichende Pathologie, Berlin). Endokrinologie, 51: 67-73(1967). (In German).

Uptake of ^{125}I or ^{131}I by guinea pig thyroid follicles was measured by autoradiography. The follicles were removed from the animals 160 min after administration of 25 to 100 μCi ^{131}I or ^{125}I. The volumes of each of 400 follicles that contained radioiodine or no radioiodine were evaluated by calculation as ellipsoids of rotation. Both groups of follicles showed a wide range of distribution volumes, and individually they varied markedly. The distribution of volumes ranged from small follicles (300 to 1400 μm^3) to large follicles (44,000 to 177,000 μm^3) and there was no correlation of size with radioiodine uptake concentration. This finding was in disagreement with the visual impression that small follicles accumulated radioiodine more quickly than larger follicles shortly after its administration. The basis for the distribution of radioiodine observed probably was the pattern of blood supply in the thyroid. (BBB)

8461 DECREASED K$^+$ CONDUCTANCE PRODUCED BY Ba^{2+} IN FROG SARTORIUS FIBERS. Sperelakis, Nick (Univ. of Virginia, Charlottesville); Schneider, Martin F.; Harris, E. J. J. Gen. Physiol., 50: 1565-83(July 1967).

The action of Ba^{++} and Sr^{++} on membrane potential (E_m) and resistance (R_m) of frog (Rana pipiens) sartorius fibers was studied. In normal Cl$^-$ Ringer's, Ba^{++} (<9 mM) did not depolarize or induce contractions, but increased R_m slightly above the control value of 3.8 ± 0.6 KΩ-cm^2. In Cl$^-$-free Ringer's (methane sulfonate) R_m was 28.8 ± 2.8 KΩ-cm^2, and low concentrations of Ba^{++} (0.05 – 5.0 mM) depolarized and induced spontaneous contractions (fibrillation) even in tetrodotoxin. In the hypertonic solution, the fiber diameters decreased, E_m increased slightly, and R_m decreased to 9.0 ± 0.6 KΩ-cm^2 (perhaps due to swelling of sarcotubules). At 0.05 mM, Ba^{++} rapidly increased R_m, decreased E_m, and induced spontaneous action potentials. Insensitivity to Sr^{++} was demonstrated. Thus, addition of 1 mM $Sr(CH_3SO_3)_2$ had no effect on either R_m or resting potential. The presence of Sr^{++} did not antagonize the subsequent action of 0.5 mM Ba^{++}. In high K$^+$ solution, the fibers were nearly completely depolarized, and R_m was decreased markedly to 1.5 KΩ-cm^2; Ba^{++} increased R_m to 6.7 KΩ-cm^2. Barium must act by decreasing K$^+$ conductance (g_K). In Ci$^-$ Ringer's, the high g_{Cl}/g_K ratio masked the effect of Ba^{++} on g_K. Thus, small concentrations of Ba^{++} specifically and rapidly decrease g_K. (BBB)

8462 THE EFFECTS OF ENDOTOXIN ON THE IMMUNE RESPONSE IN THE RAT. III. ELIMINATION OF ^{125}I-LABELED BOVINE γ-GLOBULIN FROM THE CIRCULATION OF RATS. Pierce, Carl W. (Univ. of Chicago). Lab. Invest., 17: 380-92(Oct. 1967).

The elimination of soluble heterologous protein from the circulation after intravenous injection was studied in normal and irradiated rats. They were injected with ^{125}I-labeled bovine γ-globulin (I-BGG) alone or with Salmonella typhosa endotoxin to study the effects of endotoxin on the elimination of I-BGG from the circulation. No immune elimination phase or antibody to BGG was detected after injection of I-BGG. Endotoxin stimulated a peak 19S anti-BGG response at four days, but there was no detectable immune elimination of the I-BGG. In the secondary response, immune elimination was observed only in rats producing precipitating antibody. Injection of only homologous or heterologous precipitating antibody produced rapid elimination of I-BGG in nonirradiated rats. In irradiated rats, rapid partial elimination of I-BGG was mediated by passively transferred rat 19S or 7S nonprecipitating antibody. It is postulated that both BGG and BGG with endotoxin stimulate production of antibody to a highly immunogenic subgroup of the BGG. The lack of detection of immune elimination during the primary response is due to the relative insensitivity of the methods and the small amounts of BGG which are actually eliminated. (BBB)

8463 RELATIVE BIOLOGICAL EFFECTIVENESS OF HIGH ENERGY RADIATION ON THE MITOTIC ACTIVITY IN NORMAL HEPATIC REGENERATIVE TISSUE. Voutilainen, A.; Rytila, A. (Univ. of Helsinki). Acta Pathol. Microbiol. Scand., 70: 279-84(1967).

Two days after the regeneration of the liver of rats was induced by performing 70% hepatectomy, the rest of the liver was irradiated with a dose of 300 rad at the rate of 40 rad/min. Radiation was given by 200-KV x rays, ^{60}Co γ rays, 32-MeV x rays from a betatron, and both 20- and 25-MeV betatron electrons. Tissue specimens were taken 12 hr later from the liver and mitoses were counted per 100 fields. X rays gave the lowest and 20-MeV betatron electrons the highest mitotic index. The pathological mitoses were most frequent after electron irradiation and least after ^{60}Co γ irradiation. On the basis of the mitotic frequencies, the RBE of the different types of radiation was calculated, taking the RBE for 200-KV x rays as 1. That of the ^{60}Co γ rays was 0.9 ± 0.26, which exceeded the value found in experiments with Walker cancer. This suggested that the RBE in tumors is different from that in normal growing tissue. The RBE value of photons was 0.80 ± 0.31, of 20-MeV electrons 0.52 ± 0.22, and of 35-MeV electrons 0.64 ± 0.31. Definite radiation damage was seen in dividing cells after the different types of radiation. It was relatively most marked after 20-MeV electron radiation; the percentage of pathological mitoses was 46. With all sources of radiation, pathological mitoses were significantly increased as compared with the controls; they were most frequent in anaphase and telophase. (BBB)

8464 THYMUS GLYCOGEN DURING GROWTH AND DURING REGENERATION AFTER REGENERATION IN THE C57Bl MOUSE. Treilhou-Lahille, F. (Univ., Paris). Ann. Histochim., 12: 125-36(Apr.-May-June 1967). (In French).

Postirradiation changes in glycogen were studied by histochemical means in the thymus to contrast changes occurring in developing and regenerating thymus. The animal particularly chosen for these studies was the C57Bl mouse in which radioinduced leukemia originates in the thymus. In fetuses and young male mice of this strain the periodic acid-Schiff (PAS) reaction was positive for certain cells of thymus cortex, indicating the presence of polysaccharides. Digestion with maltase allowed the colored compound that was hydrolyzed to be demonstrated as glycogen in granules in the cell cytoplasm. The PAS reaction was always negative in lymph nodes and in Malpighian follicles of the spleen in the same animals. In the thymus, glycogen appeared on the 17th day of fetal life in the C57Bl strain. After birth the number of cells showing red granules in their cytoplasm decreased rapidly as the animal aged; no glycogen in the thymus was seen one month after birth. The glycogen-bearing cells were mostly small thymocytes but it was also present in large basophilic cells in the deep cortex. These large cells contained less glycogen than the thymocytes. After a single dose of 600 R of x rays given over the whole-body, glycogen reappeared in the thymus cortex cells but in smaller quantities than in thymus cells of young animals. (BBB)

8465 UPTAKE OF ^{226}Ra FROM DRINKING WATER INTO HUMAN DECIDUOUS TEETH. Samuels, L. D. (Children's Hospital, Columbus, Ohio). Arch. Oral Biol., 11: 581-6(June 1966).

The uptake of ^{226}Ra from public water supplies into deciduous teeth was studied in communities in Iowa and northern Illinois that draw their public water supply from deep aquifers that contain natural deposits of Ra (up to 20 pCi/l). Whether there was a common factor of uptake that would make the Ra content of the exfoliated tooth a useful measure of past exposure to Ra and whether other factors influence uptake of ^{226}Ra by teeth were also examined. Representative results of assay of pools of whole deciduous teeth, together with the estimated Ra content of the drinking water to which the contributors of the teeth were exposed, are listed. Canines and molars did not have significantly different contents but incisors consistently contained more Ra than canines or molars. Variations in dentin/enamel ratio may cause these differences between incisors and canines-molars. Statistically significant differences were found between some towns. Uptake and retention of Ra in deciduous teeth were generally proportional to exposure during formation of the tooth. The results of fractional assay of teeth showed that the Ra concentration was considerably greater in enamel than in dentin. The possibility that concomitant fluoride exposure, present in several of the towns studied, would influence Ra uptake in teeth was examined, but no effect was demonstrable. It was evident that there was very little turnover of Ra in teeth once acquisition had occurred, and that there was relatively little Ra uptake by formed teeth. (BBB)

8456 THE PROPERTIES OF ^{90}Sr IN CHRONIC FEEDING STUDIES. PART I. **Fingerhut, M.; Lang, K. (Johannes Gutenberg Univ., Mainz). Z. Ernaehrungswiss., 7: 68-87(1966). (In German).**

Following chronic feeding at levels of 140 and 350 pCi ^{90}Sr/gCa, the mortality of male and female rats was studied in long-term experiments. In control groups the 50% life expectancy was 700 days, and in the 140- and 350-pCi groups it was 750 and 900 days, respectively. Various values were reported for mineral concentrations of the skeleton, Ca concentrations as a function of age, daily Ca retention of the animals, uptake of ^{90}Sr at various intervals during the feeding studies, calculation of an exponential function for uptake of ^{90}Sr with age, calculation of ^{90}Sr units as a function of the duration of the studies, comparison of ^{90}Sr units in skeletons of animals from several generations and at various times during the feeding studies, accumulation of ^{90}Sr units as a function of time, and comparison of accumulation rates for ^{90}Sr in young and adult rats. (BBB)

8467 FURTHER EXPERIENCE OBTAINED IN STUDIES ON DISPERSAL FLIGHTS OF MELIGETHES AENEUS F., MARKED WITH ^{32}P (COLEOPTERA). **Taimr, Lubomir; Sedivy, Josef; Bergmannova, Eva; Hanker, Ivo (Central Research Inst. for Plant Production, Prague). Acta Entomol. Bohemoslov., 64: 325-32(1967).**

Two methods of marking *M. aeneus* (externally and internally with contaminated food) were compared with the dipping method. The radioactivity of the beetles marked externally with contaminated rape flowers was 18 times higher than that of those marked by dipping. Aqueous solution of primary potassium phosphate ^{32}P was used for the labeling. The marked beetles could be readily detected directly on the rape stands by a field counter as early as the 10th day after the release and on 25th day in the lab. Dispersal flights of *M. aeneus* were studied during the flowering period of the winter rape. Beetles dispersed in all directions and the dispersal was not affected either by the configuration of the terrain or the direction of wind. Also, *M. aeneus* searched for secondary host plant inflorescences during the flowering period of the rape. Radioactive beetles were found at a maximal distance of 13,500 m from the release point. (TSS)

8468 LOSS OF MITOTIC INHIBITON AFTER LOW DOSE X IRRADIATION IN RAT REGENERATING LIVER. Hemingway, J. T.; Nussey, Susan (Queen's Coll., Dundee, Scotland). J. Physiol. (London), 191: 86P-7P(July 1967).

After a 200 R dose of whole-body x irradiation of partially hepatectomized rats, it was noted that many showed increased mitoses in the growing liver to the same extent as in adrenalectomized rats. This was in contrast to the expected suppression of mitoses normally seen as the radiation effect. This loss of mitotic inhibition after whole-body irradiation was studied further by giving doses of either 100, 175, or 250 R to Wistar rats of both sexes weighing about 200 g. Irradiation was done 24 hr after partial hepatectomy, and the rats killed at 29 hr. Mitotic counts on the regenerating liver showed release of inhibition with a mean of 72 mitoses per 1000 cells in 84% of rats given 175 R, compared to controls showing 33 mitoses per 1000 cells. Rats given 250 R showed a lower ratio of mitotic release and an increase of mitotic suppression. Those given 100 R underwent mitotic release. Plasma corticosteroids were measured and found not to be depleted in any of the irradiated rats, so normal corticosteroid restraint on mitosis seems ineffective. It was suggested that the stimulus for mitosis may involve a removal of normal humoral restraint by a change of redox potential around cells going into mitosis thus allowing damaged cells to replace themselves autonomously. The effect of radiation is towards oxidation, and measurement of oxidized ascorbic acid in rat plasma showed increased oxidized forms in irradiated animals though not until about 12 hr after irradiation. This suggested that oxidation occurs first in some other substance in a redox chain including ascorbic acid but supported the general theory of possible linkage of mitosis with redox potential changes. (BBB)

8469 THE TITER AND AVIDITY OF NATURAL ANTISHEEP HEMOLYSINS IN X-IRRADIATED RABBITS. Draper, Laurence R.; Owens, John R. (National Cancer Inst., Bethesda, Md.). J. Immunol., 99: 142-9(July 1967).

Details of the suppression-recovery sequences of natural hemolysins specific for sheep erythrocytes were studied in intact and splenectomized rabbits after 1 or more exposures to x rays, and the avidity of the hemolysins present was measured. Whole body irradiation was performed at 200-KV with a standard 500-R dose delivered at a rate of 139 R/min. Mean hemolysin titers and avidity in unirradiated groups of intact and splenectomized rabbits remained constant, but in intact rabbits they declined for about 12 days after irradiation. Recovery then ensued and usually led to enhanced titers during the 3rd and 4th weeks. Recovery was delayed but not impaired by a second dose of 500 R 7 days after the first one. Reirradiation during the recovery period (16 or 32 days after the first one) prompted, often after a lag of several days, a second titer decline followed by a second recovery. Hemolysin titers after irradiation of splenectomized rabbits followed the same sequence as in intact rabbits, but the decline persisted for several more days, recovery was more sluggish and significantly enhanced titers were not found 39 days after a single irradiation or 23 days after the second of two irradiations. Avidity of hemolysin, as measured by intercellular transfer, was typically low, varied widely both within groups and with time, and was independent of titer. The variability and fluctuations suggested that natural hemolysin levels are maintained by a series of small, independent responses of gamma globulin yielding hemolysin of varying degrees of specificity for sheep erythrocytes. (BBB)

8470 RESIDUAL CHROMOSOMAL ABERRATIONS IN FEMALE CANCER PATIENTS AFTER IRRADIATION THERAPY. Amarose, Anthony P.; Plotz, E. Jurgen; Stein, Arthur A. (Albany Medical Coll., N. Y.). Exp. Mol. Pathol., 7: 58-91(Aug. 1967).

Results are reported on chromosomal studies of cultured lymphocytes obtained from 14 therapeutically irradiated pelvic cancer patients who had a significant portion of the normal lymphoid and hematopoietic tissue in the path of γ rays from ^{60}Co teletherapy and intracavitary Ra. Such therapeutic irradiation produced chromosomal aberrations in peripheral circulating lymphocytes which were assessed by analysis of cells from serial, spaced peripheral blood cultures obtained during and after therapy. The initial and most immediate effects were quantitative, and affected the frequency of cells with chromosome complements deviating from the normal complement of 46. This increase in the number of aneuploid cells rose to a plateau during therapy, and by 1 yr after conclusion of therapy the number of cells with 46 chromosomes began a slow rise to pretreatment levels. Although the chromosomal complement may have reached the preirradiation modality, persisting structural aberrations of the chromosomes were seen long after radiation therapy. (BBB)

8471 FACTORS INFLUENCING THE RETENTION OF AN ORAL DOSE OF RADIOACTIVE MANGANESE BY THE CHICK. **Mathers, J. W.; Hill, R. (London Univ.). Brit. J. Nutr., 21: 513-17(Aug. 1967).**

Day-old chickens on a low-Mn diet (4 μg Mn/g) were given an oral dose of ^{54}Mn as the chloride (1.5 μCi, carrier-free) and determinations of radioactivity in liver and remaining carcass were made. The quantities of ^{54}Mn in the liver and in the whole bird were calculated as percentages of the dose. In a 2nd experiment pullets aged 4.5 weeks that had been given a low-Mn diet were dosed orally with 2 μCi ^{54}Mn, as the chloride, and varying quantities of inactive Mn as the sulfate: 0, 250, 625, 1250, 1875, 2500, or 5000 μg Mn. Retention of ^{54}Mn in the whole bird in both experiments was only a small proportion of the dose, the overall mean being only 4.0%. Of the total retained, a large proportion was present in the liver (average 36%), and there was a highly significant positive correlation between the amount in the liver and total retention. There were no significant differences in retention of ^{54}Mn by hybrid broiler cocks, hybrid layer cocks, and hybrid layer pullets, nor was retention affected by the period of fasting, i.e., 1.5 or 24 hr before dosing. Two-week-old birds retained 58% more radiomanganese than 5-week-old birds, and retention in birds killed 24 hr after the dose was only 64% of that in birds killed 4 hr after the dose. With the addition to a fixed dose of

^{54}Mn of increasing quantities of nonradioactive Mn, retention decreased only from 2.52% with no Mn added to 1.02% with 5000 μg Mn added, representing a large increase in total retention of Mn. (BBB)

8472 A QUANTITATIVE STUDY OF THE EFFECTS OF PROGESTERONE AND RELATED STEROIDS ON THE UTERUS: PLASMA CONCENTRATION RATIO FOR RADIOACTIVE IODIDE IN THE RAT. Brown-Grant, K. (Oxford Univ.). J. Endocrinol., 38: 145-61(June 1967).

In early pregnancy in the rat, the uterus : plasma (U/P) concentration ratio for radioiodide rises as high as 10.0 as compared with 0.6 in nonpregnant rats. Progesterone can replace the ovarian secretion in the pregnant animal or induce a high U/P radioiodide ratio in intact or ovariectomized nonpregnant rats. Estrogen interferes with this action of progesterone. Optimal conditions for determining the quantitative effect of a single subcutaneous injection of progesterone on the U/P concentration ratio for ^{131}I were found to be measurement of this ratio 24 hr after the injection of steroid in rats ovariectomized 7 to 10 days previously. Under these conditions there is a linear regression of response on log dose over the range of 156 to 2500 μg progesterone. Tissue : plasma concentration ratios for ^{131}I were measured 2 hr after injection of 5 μCi of carrier-free Na^{131}I intramuscularly. Reduction of the 20-ketone group or the 4–5 double bond, introduction of 17- or 21-hydroxyl groups or of an 11-oxo group into the steroid molecule reduced the activity in this test. Steroids with predominantly glucocorticoid, androgenic, or estrogenic activity did not produce this response. The results obtained in this U/P radioiodide concentration test appear to be more closely related to the ability to maintain pregnancy than are those obtained in the usual assays for progestational activity. It is suggested that the U/P ^{131}I ratio response could be made the basis of an accurate and potentially useful assay method for steroids with progestational properties. (BBB)

8473 RELATIVE DISTRIBUTION OF STORED UNSEPARATED SOLUTIONS OF URANIUM FISSION PRODUCTS IN DOGS, RABBITS, GUINEA PIGS, AND RATS. Semenov, D. I.; Borisova, N. D. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 25-40(1966). (In Russian).

The concentration of radioactive emitters in different tissues was determined in test animals that were injected with solutions containing 55 to 60% ^{144}Ce–^{144}Pr, 25 to 30% ^{90}Sr–^{90}Y, 5 to 10% ^{137}Cs, 5% ^{106}Ru, and inert impurities. Differences in elimination dynamics of emitters injected intraabdominally and intravenously are discussed. Absorption of the components of the intraabdominally injected solution was incomplete. (Only 65 to 70% of the injected material was resorbed) and uneven (Cs, Sr, and to a certain degree, Y, were resorbed from the abdominal cavity; Ce was only partly absorbed). The distribution of the unseparated solution in the organs was substantially different in different types of animals. In dogs the radioactivity of the skeleton was higher, and elimination from the liver was slower than in the other animals; the radioactivity content differed significantly in different kinds of dogs. Elimination of the emitters in urine and feces was fastest in guinea pigs, rabbits, and rats. Emitter concentration was highest in the blood of the guinea pig, and clearing of the blood was slower. Maximum emitter content was attained fastest in the organs of rabbits. Emitter concentration differed in different muscles (skeletal and cardiac) of the animal and even in different parts of the cardiac muscle. When injected as an unseparated solution, the individual emitters acted independently of one another in the organisms of the different animals. (ATD)

8474 BEHAVIOR OF UNSEPARATED SOLUTION OF URANIUM FISSION PRODUCTS IN AN ANIMAL ORGANISM. Semenov, D. I. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 13-23(1966). (In Russian).

The behavior of intravenously and orally administered stored (2.5 years) solutions of unseparated uranium fission products (UUFP) (2.5 μCi/animal) was studied in rats. Almost 90% of the orally administered UUFP were eliminated in the feces in the first 2 days; about 11% of the emitters were resorbed: Cs (comprising 5% of the mixture) was completely absorbed, 26% of the Sr–Y (35%) was absorbed, but almost none of the Ce and Ru (55 and 5%) was absorbed. When the mixture was injected intravenously, most of the radioactive material was deposited in the skeleton (30%) and in the liver (21%). Cerium and Sr–Y comprised most of the skeleton deposit. Ce was deposited in the liver, and Cs almost exclusively in the muscle. The mixture was eliminated fairly rapidly in the urine and feces: about 75% of the radioactivity was excreted by the rat in 120 days. The data obtained using UUFP mixtures was compared with data when the individual radioisotopes were incorporated. In the case of both intravenous and oral administration of the UUFP mixture, each of the emitters behaved independently of the presence of other emitters in the organism. Even the presence of inert impurities in the solutions did not alter the behavior of the individual emitters. Toxic amounts of solutions of the UUFP mixtures behaved somewhat differently than trace amounts in that they were absorbed to a lesser degree from the intestines and deposited to a smaller degree in the internal organs. In organisms of young animals, the UUFP were deposited in the skeleton to a much greater degree, and in the liver and kidneys to a lesser degree. (ATD)

8475 BEHAVIOR OF NIOBIUM IN AN ANIMAL ORGANISM. Semenov, D. I.; Balashova, G. N.; Borisova, N. N. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 5-12(1966). (In Russian).

The behavior of ^{95}Nb in organisms of the rat after intravenous oral, and subcutaneous administration was studied. Doses of 110 to 330 μCi/rat were used to determine the distribution of Nb in the organs and tissues. The intravenously injected Nb was more or less evenly distributed, with the highest concentrations in the bones, liver, kidneys and spleen; the concentration in the remaining organisms is about 1.5 to 2 times lower. The intravenously injected Nb entered the intestines mainly via the hematogenic route and not from the kidneys. Subcutaneously injected Nb was readily resorbed; its distribution among the organs was similar to that injected intravenously. The biological half-life for the bone marrow and liver was about three weeks, and for the lymph nodes, and spleen over 64 days; however, almost none of the Nb was eliminated from bone tissue during the 60 days of the experiment. Niobium entering the blood was very strongly sorbed by the plasma albumin (92%); only 0.5% remained in the globulin. Of the orally administered Nb only 0.2 to 0.3% remained in the rat; the balance was eliminated in the feces. (ATD)

8476 BEHAVIOR OF CESIUM, STRONTIUM, YTTRIUM, CERIUM, ZIRCONIUM, NIOBIUM, AND RUTHENIUM IN THE ORGANISM UPON THEIR INHALATION BY RATS. Semenov, D. I.; Moskalev, Yu. I.; Buldakov, L. A. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 49-87(1966). (In Russian).

The distribution and elimination of radioelements inhaled by rats was determined, as well as the rate and amount of resorption of these elements from the lungs and gastrointestinal tract. The deposition and elimination rates for the given radioactivity was compared when the elements were inhaled and administered orally or intravenously. Toxicity of the inhaled radioelements and causes for their differences were determined. When trace preparations of ^{144}Ce, ^{137}Cs, ^{95}Nb, ^{106}Ru, ^{89}Sr, ^{91}Y, and ^{95}Zr were inhaled as aerosols, 10 to 18% penetrated the lungs, about 60% was detailed in the oral cavity and nasopharynx, and the remaining 20 to 30%, on the skin, mostly about the snout. Cesium and Sr were completely resorbed from the lungs. About 90% of the Nb and about 50% of the amount of the other emitters were resorbed from the lungs; the remainder was detained in the lungs for a long time and partially discharged in the oral cavity. The amount of emitters detained in the oral cavity and nasopharynx, licked from the snout, and discharged from the lungs by means of ciliated epithelia was ingested and entered the gastrointestinal tract. Of this, Cs was completely, and Sr was partially resorbed from the intestines, while the remaining emitters were almost completely eliminated in the feces in the first days of the test. All the Cs, about 50% of the Sr (10% through the lungs and 40% through intestines), and 7 to 12% of the remaining emitters inhaled by the rats entered the internal organs. Distribution in the internal organs of the resorbed portion of all of the elements investigated, except Ce, was similar to their distribution when injected intravenously. From a toxocological viewpoint, inhalation of the readily resorbed emitters (Cs and Sr) gave the same pathological results as their oral administration. Inhalation of emitters that are poorly resorbed from the gastrointestinal tract (Ce, Nb, Ru, Y, and Zr) caused more noticeable changes in the lungs and internal organs since they were retained longer by the lungs and partially (50 to 60%) resorbed from them. Intraabdominal injection of sodium ethylenediaminetetraacetate (EDTA) reduced the inhaled Ce and Y content in the organs to one-half, and increased their urinary elimination. (ATD)

8477 INHALATION OF PLUTONIUM BY RATS. Tregubenko, I. P. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 89-97(1966). (In Russian).

The degree and rate of absorption of tetravalent plutonium inhaled as an aerosol of $Pu(NO_3)_4$ was studied in rats. A test chamber previously described by the author was used for the inhalation study. About 25% of the inhaled plutonium was retained by the respiratory tract. About 20% of this plutonium initially retained in the respiratory tract was resorbed from the lungs. About 70% of the inhaled plutonium passed through the gastrointestinal tract in 32 days; very little was resorbed by the gastrointestinal tract. (ATD)

8478 FATE OF PLUTONIUM IN A PREGNANT ORGANISM AND ITS EFFECT ON THE VIABILITY OF THE FETUS. Tregubenko, I. P. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 125-30(1966). (In Russian).

The effect of pregnancy on the behavior of plutonium in the organism, the degree of its transfer from the maternal organism to the fetus, and the effect of plutonium on viability of the offspring was studied in white rats inoculated with 1μCi of plutonium in the form of plutonium citrate complex. The behavior of plutonium incorporated during pregnancy differed greatly from its behavior in a nonpregnant organism and depended on the time of pregnancy: during pregnancy the deposition of plutonium in the skeleton was greatly reduced in comparison with a nonpregnant organism. Its deposition in the liver increased (by 1.5 times) at the start of pregnancy, and decreased in late pregnancy. The concentration of plutonium in the body of the mother was about the same in pregnant and nonpregnant animals; however, in the pregnant animals the placenta and amniotic fluid contained substantial amounts of the plutonium. Transfer of plutonium to the fetus increased as pregnancy advanced; during late pregnancy it reached 42% of the amount initially introduced into the mother. The increase was believed to be associated with formation and development of the skeleton in the embryo. If pregnancy occurred when the plutonium was already fixed in the tissues of the mother, the fate of the plutonium in the organism remained essentially unchanged; only 0.43% of the amount entered into the maternal organism was transferred to the fetus. Since the plutonium concentration in the fetus of an animal exposed during pregnancy was 3.3 times higher than in the mother organism, the chances of viability were small. (ATD)

8479 EFFECT OF EDTA ON BEHAVIOR OF STRONTIUM AND RARE EARTH ELEMENTS IN AN ORGANISM. Tregubenko, I. P.; Kach, A. Z.; Pani, G. E. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 131-42(1966). (In Russian).

The effect of EDTA on the behavior of strontium and rare earths in rat organisms was studied. Approximate toxic dosages of EDTA were determined. EDTA lowered calcium concentration in the blood; toxic doses caused calcium tetany, shock, and heart stoppage. EDTA had no effect on the excretion of strontium from the organism, and in some cases even increased the deposition of trace amounts of strontium in bone tissue. EDTA noticeably increased the excretion of rare earths (mixture of rare earth radioisotopes containing 85% ^{144}Ce was used) in the urine, and reduced its concentration in soft tissues (4 to 10 times in liver). Single and repeated use of EDTA affected excretion of the rare earths. The effects of dose, method of administration, and time of administration on the effectiveness of EDTA was studied. The excretion of rare earths increased rapidly and then gradually with an increase in dose. (ATD)

8480 EXPERIMENTS ON THE EFFECT OF CERTAIN MATERIALS ON THE BEHAVIOR OF PLUTIONIUM IN AN ORGANISM. Tregubenko, I. P. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 143-6(1966). (In Russian).

The effect of different types of colloidal materials and of complex-forming materials on the behavior of plutonium was studied in live organisms. The amount of plutonium excreted, and deposited in the skeleton and various tissues of white rats was determined after intraabdominal injection of the plutonium and intravenous injection of the test materials. Anionic colloids of yttrium and zirconium showed a very distinct effect in reducing deposition of plutonium in the skeleton: finely dispersed colloidal zirconium significantly increased the excretion of plutonium in urine, while the more coarsely dispersed zirconium citrate, and especially yttrium citrate, increased deposition of the emitter in the liver and spleen. The colloids lysozyme and ovomucoid effected some reduction in plutonium deposition in the skeleton, while periston actually enhanced deposition. Complex-forming materials whose complexes have low stability constants (aluminon, nitrilotriacetate, rivanol, sodium arsanilate, and urotropine) had practically no effect on the behavior of plutonium, even if used early. Of the complex-formers only cupferron reduced skeletal deposition of the plutonium to a slight extent. (ATD)

8481 REDUCED ABSORPTION OF RADIOEMITTERS FROM THE GASTROINTESTINAL TRACT AND USE OF COMPLEXONS FOR REMOVING RESORBED MATERIAL. Semenov, D. I. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 151-8(1966). (In Russian).

Experiments with 32 albino male rats showed that treatment with Na-EDTA and Co-EDTA increased the resorption of radiometers (^{144}Ce, ^{91}Y, and mixed solution) by the gastro-intestinal tract. Barium sulfate and Espatite-1 reduced the resorption of strontium from the gastro-intestinal tract; turfite was less effective. The hydrogen form of espatite-1 inhibited cesium resorption by the gastro-intestinal tract while turfite was completely ineffective. Introduction of lead sulfate increased the life-span of rats fed with water containing toxic doses of mixed radioemitters. Under identical conditions, treatments with barium, calcium, fluorite, and espatite were very ineffective. (R.V.J.)

8482 THE RNA METABOLISM OF DATURA TISSUES AFTER AN X IRRADIATION. Brucker, W.; Rohde, H.-G. (Ernst-Moritz-Arndt-Univ., Griefswald, Ger.). Ber. Deut. Bot. Ges., 79: 134-42(1966). (In German).

Within 14 days after treatment with 3000 R of 200 kV x irradiation, the in vitro growth of a crown gall tissue culture obtained from Datura, type P_x was decreased by ~60%, as indicated by RNA metabolism. The irradiations had no effect on the total amounts of nucleotides or the nucleotide composition of the RNA. Incorporation of ^{32}P into the nucleotides of RNA was reduced by 35% within eight hr following irradiation, as compared to control tissue cultures. Several differences between the effects of irradiation on specific nucleotides were observed within 24 to 48 hr after irradiation. These included inhibition of cytidylic acid and guanylic acid metabolism by 25%, 60% increased ^{32}P incorporation into uridylic acid, but no change of ^{32}P incorporation into the adenylic acid. (BBB)

8483 DEVELOPMENT OF DISEASE DUE TO A CYTOMEGALIC VIRUS IN ISOGENIC THYMECTOMIZED RADIOCHIMERAS. Jahkola, M.; Atanasiu, P.; Duplan, J. F. (Institut Pasteur, Paris). Ann, Inst, Pasteur, 112: 781-97(June 1967). (In French).

The infection caused by the cytomegalic inclusion virus in normal and thymectomized isogenic radiation-induced mouse chimeras was studied to evaluate the effects of thymectomy and the immunological deficiencies related to it on the course of a viral disease. The radiochimeras had received whole-body irradiation to destroy the hematopoietic cells, later restored by grafts of such cells from an isogenic donor. Normal chimeras restored after irradiation by fetal liver cells had normal immune reactions. The mortality, extent and severity of histological lesions, and reaction of the lymphoid organs were similar to those encountered in unirradiated control mice. When spleen cells instead of fetal liver cells were used in the restoration of the mice, the animals were more sensitive to viral infection, as seen by increased mortality, but no new specific histological changes could be observed. Similar results were obtained in earlier studies on immune reactions measured by the graft-vs-host technique. Thymectomized radiochimeras were much more sensitive to cytomegalic virus than normal radiochimeras. Those restored by spleen cells showed signs of weak immune reactivity, i.e., a few secondary nodules in the lymphoid follicles and increased spleen weight. On the other hand, thymectomized radiochimeras restored by fetal liver cells were incapable of any immune response, as seen by the absence of secondary nodules in lymphoid follicles and unchanged spleen weight. The mortality rate was equally high in both groups, indicating that the weak immune reactivity conferred by spleen cells was insufficient to control the outcome of the infection. The amount of infectious virus present in the salivary glands, spleen, and liver varied during the course of the infection, but significant differences were not registered between various mouse groups. These results indicated that thymectomized radiation-induced chimeras cannot regenerate their immunologically competent cell (ICC) population from precursor cells, and that, in the absence of the thymus, the ICC's of the adult spleen are unable to reconstitute totally and to maintain an ICC population compatible with a normal immune response. The high sensitivity of thymectomized radiation-induced chimeras to infectious agents of low pathogenicity such as the cytomegalic virus was attributed to their deficient immune response. (BBB)

8484 INHIBITION OF GASTROINTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM WITH SOME ION EXCHANGERS. Kubodera, Akiko (Tokyo Coll. of Science); Akamatsu, Yuzuru Yakugaku Zasshi, 87: 719-25(June 1967). (In Japanese).

Investigations were made on sulfonated polystyrene ion exchange resin, phosphonated polystyrene ion exchange resin, and sulfomethylcellulose ion exchanger. The ion exchangers were shaken in suspension with the solution of radiostrontium in flasks containing calcium salt in several concentrations. Adsorption of radiostrontium by ion exchangers increased with the decrease in the concentration of calcium in the medium. In a medium of physiological concentration (10 m mole) of calcium salt sulfonated polystyrene resin rapidly adsorbed more than 98% of radiostrontium. Sodium, calcium, and strontium forms of the resins were administered to rats, mixed in their diet containing radioactive strontium in the form of calcium strontium carbonate. Calcium form of sulfonated polystyrene resin is the most effective in inhibiting gastrointestinal absorption of radiostrontium. The larger the amount of the resin in the diet, the larger was the amount of radiostrontium in the feces. A diet containing the resin of the calcium form in 40% of the diet inhibited the absorption to the level of $^1/_2$ to $^1/_8$ of the control group. (NSA of Japan)

8485 MEDICAL RESEARCH COUNCIL RADIATION RESEARCH AT THE HAMMERSMITH HOSPITAL: RADIOBIOLOGY. Alper, Tikvah (Hammersmith Hospital, London). Proc. Roy. Soc. Med., 60: 783(Aug. 1967).

Some radiobiology research projects being pursued are briefly surveyed. There appears to be no basic difference in the response of normal and neoplastic cells to radiation, but there is good evidence that many tumors contain foci of cells that are hypoxic and thus more resistant to radiation than normal well-oxygenated cells. The operation of the oxygen effect, and methods of circumventing the disadvantages it presents in tumor therapy, are discussed, as well as some aspects of the effects of dose fractionation and changes in the proportion of anoxic cells in tumors that occur after irradiation. A wide variety of types of ionizing radiations is used at a range of dose rates. The cyclotron is employed as a source of charged particles, from which much can be learned about basic mechanisms; it is also a source of fast neutrons which are being used in a clinical radiotherapeutic trial because the differential effects on well and poorly oxygenated cells are much less marked with these fast neutrons than with x or γ rays. Electron beams are available from a linear accelerator, allowing very high dose rates, which make possible studies in which megarads and tens of megarads are required. (BBB)

8486 DEVELOPMENT OF THE PROGENY OF RATS SUBJECTED TO THE SYSTEMATIC ACTION OF ^{90}Sr. Shvedov, V. L.; Korytnyi, V. S. Radiobiologiya, 7: 433-7(1967). (In Russian).

The development of six litters of young rats born of parents both of which received ^{90}Sr in doses of 0.00005 to 0.5 μCi per day in feed was studied. The young rats weighed less and exhibited retarded development as compared with the progeny of untreated rats. The amount of ^{90}Sr absorbed by the young rats and their parents increased until the upper limit of absorption by the parents was reached at the fourth litter and then remained constant. The litters born to the experimental rats were smaller than those of control rats. The number of young rats that died during lactation increased in direct relation to the logarithm of the dose absorbed by the parents. The action potential of skeletal muscle fibers of young rats exposed to ^{90}Sr increased at the same rate as that of control rats up the 15th day of life; then the rate of increase began to lag behind that of controls, with the reduction in the rate increasing with increasing daily doses of ^{90}Sr ingested by the parents. (JPRS)

8487 ACTIVITY OF DEOXYRIBONUCLEASE II IN THE BLOOD SERUM AND SOME TISSUES OF RATS INJURED BY ^{90}Sr. Uspenskaya, M. S. Radiobiologiya, 7: 468-70(1967). (In Russian).

Subcutaneous injection of ^{90}Sr into rats increased the DNAase II activity in the blood serum. The maximum increase took place on the fifth day after the injection. It amounted to 200 and 300% after injection of a dose of 2 and 4 mCi/kg, respectively. The maximum increase of DNAase II activity in the spleen and bone marrow was observed 24 hrs after the injection; the activity of the enzyme in these organs returned to ~ normal on the third to fifth day after the injection. Because the DNAase II activity was at a maximum level above normal in the blood stream at a time when it had returned to normal in the spleen and bone marrow, the increase of the DNAase II activity in the blood serum was considered to be caused by radiation damage to cells of tissues other than those of the spleen and bone marrow. (JPRS)

8488 LIPOPROTEINS OF THE BLOOD SERUM AND OF SOME ORGANS OF IRRADIATED RATS. Vinogradova, M. F.; Makhlina, A. M.; Rubtsova, Yu. V. Radiobiologiya, 7: 387-91 (1967). (In Russian).

The content of β-lipoproteins in the blood serum, the wall of the small intestine, the liver, the brain, and skeletal muscles of rats 72 hrs after irradiation of the animals with 1200 R of rays was determined by paper electrophoresis and by the turbidometric method of M. Burstein and J. Samaille [C. R. Acad. Scien., 243(25): 2185 (1956); 245(26): 2558 (1957)]. Changes in the content of β-lipoproteins were determined by subcutaneous injection of radioactive sodium acetate into the rats and determining the activity of the isolated lipoproteins. The content of β-lipoproteins in the liver of irradiated animals decreased to a minor extent, while the activity corresponded to that established for control animals. Both the content and activity of β-lipoproteins decreased in the intestinal wall; this indicated suppression of their synthesis as a result of irradiation. The amount of β-lipoproteins in skeletal muscles remained unchanged while their activity decreased under the effect of irradiation, i.e. the rate of catabolic processes was apparently reduced. No changes in the content or rate of synthesis of β-lipoproteins of the brain took place following irradiation. In the blood serum the concentration of β-lipoproteins increased under the effect of irradiation, while their activity remained unchanged; this was presumably associated with a compensatory rise of the release of β-lipoproteins into the blood by some organs. (JPRS)

8489 GLYCOLYSIS IN ERYTHROCYTES AFTER γ-IRRADIATION. Gerasimova, G. K. Radiobiologiya, 7: 392-7(1967). (In Russian).

The glycolytic activity of rat erythrocytes irradiated in vitro with γ rays at 50 to 150 kR showed phasic changes, as indicated by their degree of utilization of glucose; the rate of glycolysis increased for 1 to 2 hours and gradual inhibition set in. The activation effect, as far as its magnitude and duration were concerned, depended on the radiation dose, the temperature of preliminary incubation, and the abundance of O_2 at the time of irradiation. Activation took place at a time at which structural changes in the erythrocytes had developed only to a minimum extent. The phasic changes in glycolysis in the early postirradiation period coincided with similar changes in the incorporation of ^{42}K into the erythrocytes. It was assumed that activation of glycolysis compensated for disturbances in the ionic equilibrium that were due to the effect of radiation on the transfer function of the erythrocyte membrane. On irradiation of the erythrocytes with prehemolytic or hemolytic doses (100 to 200 kR) and at later times after irradiation with smaller doses, structural changes produced by radiation were the principal factor affecting glycolysis. (JPRS)

8490 BIOLOGICAL FACTORS. Thompson, R. C. (Battelle Memorial Inst., Richland, Wash.). pp 785-829 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

A review on the biological factors involved in the control of plutonium hazards is organized under three principal headings. Consideration is first given to the physiological factors that determine the behavior of plutonium in biological systems. This is followed by consideration of toxicological factors—the manifestations of biological effects resulting from exposure to plutonium. The physiological and toxicological findings are then brought to focus on the practical problem of hazard evaluation and the establishment of permissible exposure limits. (216 references). (P.C.H.)

8491 RADIOACTIVE ^{54}Mn AND ^{65}Zn IN EURYHALINE FISH. Gustafson, P. F. (Atomic Energy Commission, Washington, D. C.); Brar, S. S.; Nelson, D. M.; Muniak, S. E. Can. J. Zool., 45: 729-35(Oct. 1967).

Radioactive ^{54}Mn and (or) ^{65}Zn were found in the seven species of euryhaline fish examined: alewife, char, ell, salmon, shad, smelt, and sturgeon. These two radionuclides were not observed in any of the more than 30 stenohaline species investigated. Retention of ^{65}Zn was deomonstrated only in euryhaline fish taken from a marine (saltwater) environment, whereas ^{54}Mn was retained by euryhaline fish living in either fresh or salt water. Their complex osmoregulatory systems, in addition to their feeding habits, are advanced as causal factors for the accumulation of ^{54}Mn and ^{65}Zn by euryhaline fish. Because shad and salmon (and probably both the sturgeon and char) were caught during the spawning migration there may be a hormonal influence as well on the metabolism of ^{54}Mn and ^{65}Zn. (auth) (Canada)

8492 EXPERIMENTAL IRRADIATED ARTHROSPORE VACCINE AGAINST COCCIDIOIDOMYCOSIS IN MICE. Pulliam, James D.; Converse, J. L.; Snyder, E. M.; Esterly, J. R.; Lowe, E. P. (Fort Detrick, Frederick, Md.). J. Bacteriol., 94: 1394-9(Nov. 1967).

An experimental irradiated (^{60}Co) arthrospore vaccine against coccidioidomycosis protected approximately 75% of mice from death after an intraperitoneal challenge sufficient to kill approximately 90% of the nonimmunized control mice. Although the majority of the immunized mice became infected with Coccidiodes immitis, the histologic lesions were substantially less severe than those in the nonimmunized controls, particularly in the pulmonary region. Although arthrospores irradiated with 1, 2, or 3 million roentgens lost their ability to multiply in various laboratory media (probably through interference with cell division), partial conversion to the parasitic phase (spherule) was observed after animal inoculation (rounding out of arthrospores into immature spherules, but without development of endospores). Duration of viability of these structures has yet to be determined. (auth)

8493 DEOXYRIBONUCLEIC ACID REPAIR REPLICATION AFTER ULTRAVIOLET LIGHT OR X-RAY EXPOSURE OF BACTERIA. Billen, D.; Hewitt, R. R.; Lapthisophon, T.; Achey, P. M. (Univ. of Florida, Gainesville. M. D. Anderson Hospital and Tumor Inst., Houston, Tex.). J. Bacteriol., 94: 1538-45(Nov. 1967).

A comparison of repair synthesis after ultraviolet light (uv) or x-ray exposure was made in Escherichia coli strains 15T$^-$ (555–7) and B/r by use of a D, ^{15}N, ^{13}C density labeling system. During the initial 15 min of incubation after uv irradiation, both a repair synthesis and a reduced semiconservative deoxyribonucleic acid (DNA) synthesis occurred. In the so-called "physiological" dose range used, the latter was greater than the former. X irradiation of cells, at doses producing similar levels of cell death as in the uv-exposed cultures, did not lead to a similar repair replication process. However, a density heterogeneity of the DNA synthesized in the initial 10 min after exposure was observed. This is interpreted in terms of x ray-induced DNA degradation. Normal cells showed only a semiconservative type of replication and, therefore, within the limits of resolution of the system used (the incorporation of 1,000 to 5,000 nucleotides per replicating chromosome could be measured), DNA in normal cells did not appear to undergo a repair synthesis involving thymine exchange. These results indicate that not all repair mechanisms mimic that found after uv exposure. (auth)

8494 SELECTIVE INHIBITION OF ION ABSORPTION BY URANYL. Mason, Benjamin Jordan. Corvallis, Oreg., Oregon State Univ., 1967. 171p.

Thesis.

The effects of uranyl (UO_2^{++}) upon the absorption of Li, Na, K, Rb, and Cl were evaluated. Owing to the biological importance of Na and K, these two ions were studied in the greatest detail. The results showed that, at UO_2^{++} concentrations above 1×10^{-1} milliequivalents per liter and pH's above 4.5, uranyl selectively inhibited K and Rb absorption but had essentially no effect upon Na and Li. Under these same conditions it was concluded that uranyl polymers such as $(UO_2)3(OH)_4^{++}$ were formed. It was suggested that these polymers produced the inhibition of K and Rb absorption. The results of this study suggest that there are at least two carriers transporting Na and K. One of these carriers was inhibited by the higher uranyl concentrations at pH's above 4.5. This carrier shows a preference for K. The second carrier was unaffected by UO_2^{++} and showed a preference for Na. When only one of this pair of ions was present it could travel via either of the carriers. Competition of K with Na was greatest during absorption via the UO_2^{++}-sensitive carrier. Na competition with K was greatest during transport via the UO_2^{++}-resistant carrier. It is suggested that UO_2^{++} may bind to a phosphate containing organic compound which is either the K carrier or a compound closely related to this carrier. (Disser. Abstr.) (TSS)

Ecology

Refer also to abstract 8550.

8495 (COO–1355-17) ECOLOGICAL CONSIDERATION OF NUCLEAR DETONATIONS AND ACARINA RELATED TO ZOONOSES. Allred, Dorald M. (Brigham Young Univ., Provo, Utah. Dept. of Zoology and Entomology). Oct. 24, 1966. Contract AT(11-1)-1355. 7p. (CONF-670703–1). DTIE.

From 2nd International Congress of Acarology, Nottingham, England.

Studies of the ecology of animals at the Nevada Test Site are reported. Ectoparasites were more numerous on rodents living adjacent to buried nuclear waste than on those living in areas of normal background radiation. Factors determining the maintenance and spread of zoonoses are discussed. It is pointed out that immunity of animals to infestation by ectoparasites may be affected either adversely or favorably by inhabitation of irradiated areas. (H.L.W.)

8496 CONTAMINATION OF FOOD WITH FRESH RADIOACTIVE FALL-OUT. Aberg, B. (Royal Veterinary Coll., Stockholm). Bibl. Nutr. Dieta, 9: 32-42(1967).

Studies were performed to provide a basis for decisions to use various means to diminish the hazards to children's thyroids in the event of fresh fallout. When Na^{131}I was administered as a single oral dose to a cow its milk contained 0.08% of the dose administered per liter of milk produced half an hour later. The maximal concentration was found in milk produced at 6 hr, or between 1.55 and 1.92% of the dose. Six days later the milk contained only 0.02% of the dose. Nuclear weapons test by USSR in 1962 resulted in the appearance of ^{131}I in Swedish milk; it varied from August 28th and December 3rd, 1962 between 0 and 406 pCi/l. At some farms up to 3000 pCi/l was found and during 1962 the mean ^{131}I intake in Sweden was 30 nCi/person. It was decided that an accumulated yearly intake of 200 nCi in peacetime warrants action from a public health point of view. After administration of ^{131}I as NaI in aqueous solution to hens, a rapid uptake in the bloodstream took place, and the maximal concentration of radioiodine in the yolk of the eggs was found to be 0.15% of the dose per g and occurred about 5 days later. From a public health point of view, eggs will never be of the same importance as milk as a source of radioiodine intake from food produced after fresh radioactive fallout. Also, meat contains very little radioiodine and cannot be regarded as hazardous. (BBB)

Genetics and Cytogenetics

Refer also to abstracts 8577, 8588, and 8652–8656.

8497 (CONF-670305–, pp 45-50) CHROMOSOME DAMAGE. Wolff, Sheldon (California Univ., San Francisco. Medical Center).

The relative biological effectiveness of ionizing radiations of high and low energy transfer in producing chromosome aberrations is reviewed. The mechanisms by which these ionizing radiations produce chromosome aberrations that in turn lead to intergenic or intragenic mutations are discussed. (B.H.S.)

8498 (CONF-670305–, pp 81-7) RECENT STUDIES ON THE GENETIC EFFECTS OF RADIATION IN MICE. Russell, W. L. (Oak Ridge National Lab., Tenn.).

Results of recent experiments, with emphasis on current studies at Oak Ridge National Laboratory, are discussed. Of primary concern are factors effecting mutation frequency. These factors include: effects of radiation dose rate, effects of interval between irradiation and conception, and the effects of low doses. All of these have a strong bearing on the estimation of the genetic risks of radiation exposure. (E.R.B.)

8499 HIGH FREQUENCY TRANSDUCTION OF GALACTOSE MARKERS BY PHASE ϕ170. Iijima, Teiji (Inst. of Fermentation, Osaka). Nippon Idengaku Zasshi, 42: 1-10(Feb. 1967).

Lysates prepared by uv induction of the ϕ170 lysogenic syngenote transduced the galactose markers with high frequency (HF). Characteristics of the HF lysate and the properties of transductants isolated in this system are reported. All bacterial strains used were derivatives of Escherichia coli K12. Ability of transductants to produce active phage was tested by the replica-plating technique with strain F1 as indicator bacteria. The plates were irradiated by a uv lamp (Toshiba GL15) at a distance of 50 cm for 30 to 40 sec to induce the prophage. High frequency of transduction of the Gal markers was observed with lysates prepared from strains Gal$^-$ (ϕ170dg) (ϕ170) and Gal$^-$ (ϕ170) (ϕ170dg). The former was obtained by superinfecting immune syngenote Gal$^-$ (ϕ170dg) with ϕ170, the latter by tranduction with Gal$^-$ (ϕ170) as recipient. The two strains produced active ϕ170 and showed the same immunity and segregational pattern. Doubly lysogenic strains such as Gal$^-$ (ϕ170dg) (λ), Gal$^-$ (ϕ170dg) (434) and Gal$^-$ (ϕ170dg) (ϕ80) were isolated by superinfecting immune syngenote Gal$^-$ (ϕ170dg) with active phages. These strains liberated active ϕ170 phage after uv induction. The proportion of active ϕ170 in these lysates varied considerably and appeared to be determined by the superinfecting phages. Induction of Gal$^-$ (ϕ170dg) (λ) yielded an HF lysate. (BBB)

8500 APHID POPULATION EXPLOSION INDUCED BY CHRONIC GAMMA IRRADIATION OF A FOREST. Woodwell, G. M.; Brower, J. H. (Brookhaven National Lab., Upton, N. Y.). Ecology, 48: 680-3(Summer 1967).

An irruption of aphids occurred during the summer of 1963 in the Brookhaven Irradiated Forest; the aphid population expanded suddenly to several hundred times the normal density. The high aphid density was correlated with the intensity of irradiation. Density of aphids in the forest was estimated by counting winged adults on leaves of white oak (Quercus alba), the principal host. The aphid (Myzocallis discolor) was first observed in the irradiated forest in early June of 1963, about 18 months after installation of the source and commencement of chronic irradiation. By the third week of June, the aphid was abundant on radiation-damaged oaks but apparently not present in the undamaged forest. Aphids occurred in varying degrees of abundance on white oak leaves at radiation exposures of 2 R/day and above. Oaks exposed to 9.5 R/day for 18 months supported maximum aphid populations, i.e., 25 winged adults per leaf (350,000/m^2 of forest). The irruption was correlated with changes in predator populations and with small changes in the sugar, total N, and lipid content of white oak leaves; the relative importance of these two sets of factors could not be determined. (BBB)

8501 EVALUATION IN R_2 OF THE EFFECTS OF IONIZING RADIATION ON THE GENETIC VARIABILITY OF LEAF CHARACTERISTICS IN NICOTIANA TABACUM. Bagnara, D.; Palenzona, D. L.; Wittmer, G. (CNEN, Rome. Univ., Pavia, Italy. Istituto Scientifico Sperimentale per i Tabacchi, Rome). Genet. Agr., 18: 389-94(Sept. 30, 1964). (In Italian).

The mutagenic effect of ionizing radiations on quantitative characters is usually estimated by an increase in genetic variability, that is expressed in terms of variances, in R_3 and subsequent generations. Variability is considered from the R_3, because at this level there occurs the constitution of the genetically differentiated lines derived from individuals segregating in R_2. However, if the purpose is to compare the effect of many mutagenic agents, or of more than one dose of the same mutagenic agent, it is advantageous to obtain mean estimates of genetic variances in R_2, by means of matrix calculations. By this way, single estimates of genetic variance, previously obtained through hierarchical analysis of variance, may be used. This method was applied to the experimental data concerning three leaf characters in three varieties of Nicotiana tabacum, treated with three doses of x rays (9,000 R, 18,000 R and 0 R). The results obtained show that genetic variance induced by ionizing radiations is larger than that estimable in control material and that there is a differential response between different varieties. (auth)

8502 STUDIES ON MICROBIAL RIBONUCLEIC ACID. IV. TWO MUTANTS OF SACCHAROMYCES CEREVISIAE LACKING N^2-DIMETHYLGUANINE IN SOLUBLE RIBONUCLEIC ACID. Phillips, John H. (Makerere Univ., Kampala, Uganda); Kjellin-Straby, Kerstin. J. Mol. Biol., 26: 509-18(June 28, 1967).

Mutants induced by uv and x radiation in Saccharomyces cerevisiae are described that have deficiencies in base composition of soluble RNA (sRNA). Two strains lacked the base N^2-dimethylguanine in their sRNA. Apart from this omission, the distribution of methylated bases in the sRNA was similar to that in the sRNA from a variety of other S. cerevisiae mutants. Enzyme preparations from these latter (N^2-dimethylguanine-containing) mutants may be utilized in vitro for the synthesis of this base in the sRNA from those mutants which lack it. (BBB) (TSS)

8503 INDUCED MALE STERILITY IN JUTE (CORCHORUS CAPSULARIS L.). Rakshit, S. C. (Univ. of Kalyani, West Bengal, India). Nippon Idengaku Zasshi, 42: 139-43(Apr. 1967).

Dry seeds of JRC-212, an improved cultivated strain of jute, were irradiated with 50-KV x rays for doses ranging from 10,000 to 100,000 R. In the M_2 generation, mutants with marked phenotypic peculiarities were isolated from a line receiving the 70,000-R treatment. These mutants were designated as Ribbon because of their leaf character. Among many other variations, Ribbon mutants also showed complete male sterility. Morphologic and genetic observations were made in subsequent generations from the segregating lines obtained from the heterozygous normal sibs of the mutants as well as from the progenies of crosses between the mutant and the parental strains. The Ribbon mutants were dwarfs with slow growth rate. Lower leaves were flat, narrow, and ribbon-like with very irregular margins. Genetically, the normal leaf trait was found to be dominant over the Ribbon trait and male fertility over sterility. The leaf variation is controlled by one factor pair as is male sterility. The trend of fluctuation of pollen sterility in the F_2 population indicated the probable presence of two closely linked genes controlling the two traits. (BBB)

8504 RADIATION EFFECT OF MONAZITE SAND. Kaul, B. L. (Regional Research Lab., Jammu, India). Nucleus (Calcutta), 10: 33-6(June 1967).

Monazite sand contains ^{232}Th and its daughter elements which emit α, β, and γ rays. India has rich deposits of this sand in the coastal parts of the Kerala and Madras states extending from Kayankulam to Cape Comorin. A high uptake of several radioisotopes by different species of plants in this region has been reported, as well as several spontaneously arising morphologic mutants in this region. A study was made of the cytological effects occurring in barley root meristems treated with monazite sand (monazite fraction 21%). The seeds were kept in the sand for 60 days and then allowed to germinate in it after moistening with water. The seeds had an initial moisture content of about 10%. Cytological study was made of root tip mitoses. Several types of abnormalities were encountered, including chromosome breaks, exchanges (mainly of the dicentric type), tetraploidy, nonsynchronized chromosome condensation, and reduction in seedling height. The presence of breaks, dicentrics, rings, and fragments indicated that both single and double hit events occurred. In 150 cells scored there were 199 breaks and 40 exchanges, i.e., nearly 20% of the breaks rejoined to give exchanges. These breaks were presumably caused by the radiations emitted by the radioactive elements in the sand. Tetraploidy was observed in some cells, where a preponderant number of cells showed 2n = 28 compared to the normal diploid state, probably due to failure of cell wall formation at the conclusion of anaphase. Multipolar grouping of the anaphase chromosomes also reflected abnormal metabolic processes within the cells. Height of the seedlings measured on the seventh day was reduced by 20% from the controls. The observations show that the radioactive monazite sand is capable of inducing many changes in cellular metabolism and chromosomes, and may prove to be a useful mutagen. (BBB)

8505 MUTATION INDUCED BY IRRADIATION OF A SOYBEAN VARIETY TSURUNOKO. Narikawa, Tsimei (Dorichu Agricultural Inst., Japan). Hokuno, 30: 12-13(Apr. 1963). (In Japanese).

Experiments were conducted to determine the effect of irradiation on plant seeds to improve their quality. The Tsurunoko variety of soybean has the characteristics of large size and white color, but also of harvesting late and low yield. In the experiment described, the dried seeds of the soybean were γ irradiated with ^{60}Co at 6, 10, 15, and 20 KR doses and planted under the usual conditions. Some young R_1 plants from the irradiated seeds showed changes in the morphology of leaves and pigment distribution. As the irradiation dose increased the ripening period became later and the leaves fell earlier. These observed physiological disturbances in the plant agreed with the results of other investigators. Mutations induced by irradiation were observed in the R_2 generation. They resulted in changes in the cotyledon to a yellowish white color and early ripening, with the formation of short or mosaic types. The incidence rate of mutations in color and early ripening was 3.75% at 6 KR and 4.50% at 10 KR. In the R_3 generation, early ripening and vigorous growth types were found. In the R_4 generation, 70% of the plants showed early ripening with high seed productivity; heavier seed weight and higher protein content of the seed were also observed. (BBB)

8506 CHROMOSOME ABERRATIONS IN ACCIDENTALLY IRRADIATED HUMAN SUBJECTS. Sugawara, Tsutomu (Kyoto Univ.); Hashimoto, Tetsuaki Nippon Igaku Hoshasen Gakkai Zasshi, 27: 129-33(May 1967).

Chromosomes in peripheral leukocytes from five radiation workers exposed accidentally to whole-body irradiation, two persons to external irradiation of x or γ-rays and three to internal irradiation with enriched uranium were analyzed. Incidences of chromosome aberrations observed in the first group were in the range expected from the reported data, but those in the second group were extraordinarily high. (NSA of Japan)

8507 STUDY OF INDUCTION OF IRRADIATED MUTANTS BY GAMMA RAYS AND THEIR UTILIZATION IN FLOWER PLANTS BREEDING. I. INTERSPECIFIC DIFFERENCE OF RADIOSENSITIVITY AND OCCURRENCE OF SOME VARIANTS IN ANNUAL AND BIENNIAL FLOWER PLANTS. Saito, Kiyoshi Engei Gakkai Zasshi, 35: 80-8(Mar. 1966). (In Japanese).

Dry seeds of various annual and biennial flower plants, including a total of 49 species (one hundred and more varieties and strains), were exposed to acute gamma rays from ^{60}Co at the Japan Atomic Energy Research Institute, Tokai, to ascertain the influence of radiation effect upon the plant growth and to obtain any useful mutants for breeding materials. Some noticeable biological phenomena were observed. Distinguishable interspecific differences of radiosensitivity were observed. Many plants examined were classified conveniently into the following five groups, regard to their radiosensitivity for survival: very resistant (for example, Matthiola incana, Cheiranthus cheiri), resistant (Brassica campestris, Brassica oleracea), medium (Glycine max, Cleome spinosa), susceptible (Portulaca gradiflora, Lychnis coronaria), and very susceptible (Capsicum annum, Cosmos sulphureus). Some interesting and noteworthy variants were obtained in X_1 generation or the successive descendants. The conspicuous examples include fasciation of main stems (Cosmos bipinnatus), defasciation of broadly flattened stalks (Celosia cristata), color change of petals (Moricandia sonchifolia), formation of polyfoliaged leaves (Trifolium repens), and duplication of petals (Cheiranthus cheiri). Although a part of these variants were sterile, some of the remainder were viable and are still segregating the peculiarly characterized seedlings in their progenies. (NSA of Japan)

8508 RADIOSENSITIVITY OF DORMANT SEEDS OF CREPIS CAPILLARIS AT VARYING WATER CONTENTS. Nemtseva, L. S. (Inst. of General Genetics, Moscow). Dokl. Akad. Nauk SSSR, 174: 218-20(May 1, 1967). (In Russian).

Air-dried seeds of Crepis capillaris containing 6% water were dried over granulated KOH or over P_2O_5 to decrease the moisture content. The seeds were then given an x ray dose of 1500 R, steeped on wet filter paper, and sprouted in a 0.01% colchicine solution at a temperature of 24°C. The percent chromosomal aberrations at metaphase was determined. The percent cells with aberrations increased from 7.52 ± 0.75% at 6% water content to 36.01 ± 0.99% at 2 to 4% water content in the seeds, and then fell sharply to 2.32 ± 0.33% at ~1% water content and 0.81 ± 0.22% at ~0% water content. There is a strong decrease in the radiosensitivity of seeds from which water was removed as completely as possible. (TTT)

8509 POPULATION GENETICS. PART I. DROSOPHILA. **Sperlich, Diether (Univ., Vienna).** Fortschr. Zool., 18: 223-78(1967). (In German).

Genetic burdens in certain irradiated Drosophila populations are reviewed. Effects on populations of D. ananassae irradiated by atomic bomb tests were inconclusive. After single irradiation of 70,000 D. willistoni with a high dose and subsequent isolation the lethal factor frequency decreased to normal after five generations, but the allele rate remained high, indicating that single heterotic lethal factors reached an increased frequency. In other studies with this species and with D. subobscura and D. pseudoobscura it was found that the inversion density decreased after irradiation; the adaptive inversion system was disturbed, and the lethal factor frequency returned to normal after 1½ yr. The frequency of irradiated chromosomal types decreased initially and then became normal after irradiation of D. pseudoobscura that had AR and CH chromosomal structural types. In populations of D. melanogaster irradiated once or chronically, the fitness components of egg hatch rate and egg-imago survival rate reached 70 to 75% of normal after a few generations. At this time the populations contained 60 to 90% lethal II chromosomes. This lethality was eliminated slowly and incompletely. The egg hatch rate of irradiated D. willistoni did not reach normal value 15 generations after irradiation. After 2½-yr of irradiation with 65,000 R the number of individuals of two populations of D. melanogaster reached the starting value after an initial decrease. Decreased growth capacity was demonstrated in irradiated D. pseudoobscura populations. Radioinduced chromosomal inversions were observed in Chironomus tetans populations. About 25% of irradiated D. melanogaster populations showed chromosomal structural changes, and many translocations were observed after neutron irradiation. It was concluded that general conclusions about the increased mutation rates observed in irradiated populations could not be made. (BBB)

8510 INDUCTION OF AN EARLY MUTANT IN ORYZA SATIVA LINN. BY RADIOACTIVE PHOSPHORUS. **Majumder, Balaram (Bose Inst., Calcutta). Trans. Bose Res. Inst. (Calcutta), 28: 57-64(1965).**

Attempts to induce earliness in paddy by the use of radioactive phosphorus are described. Dry seeds of the variety Chinsura Boro II (a spring-paddy) were irradiated with radioactive phosphorus (30 μc/seed). From the P_2 generation, one plant was selected (S.369) for its early flowering behavior. It was noticed that the progeny of the selection S.369 flowered nine days earlier than the control plants. Grains of the selection S.369 were awnless as against the presence of long awns in grains of the control. Changes in the mean time of flowering in S.369, associated with other changes of agronomic character, were noticed for two successive years. Mean plant height, mean number of tillers and mean number of panicles per progeny of the selection S.369 were lower than those of the control. Mean length of panicles and flag leaf and also yield per plant were significantly lower in S.369 than in the control. Pollen grains of S.369 were found to be bigger than those of the control plants. Cytological investigation of S.369 and Chinsura Boro II (control) showed that both had the same chromosome number ($2n = 24$, $n = 12$). Meiosis was regular in S.369 and the control. No detectable morphological differences were found in the chromosomes of the mutant. (auth)

8511 TWIN SPOTS AS EVIDENCE FOR MITOTIC CROSSING-OVER IN ASPERGILLUS INDUCED BY ULTRA-VIOLET LIGHT. **Wood, S.; Kafer, E. (McGill Univ., Montreal). Nature (London), 216: 63-4(Oct. 7, 1967).**

Somatic crossing-over was first described for Drosophila, twin spots of mutant cells occurring on the abdomen of which were produced by crossing-over at the four strand stage of mitosis. Evidence was subsequently obtained for a reciprocal four strand mechanism of intergenic mitotic crossing-over in the fungus Aspergillus. The present authors developed two diploid strains of the latter, and used them to study mitotic recombination produced by uv light. When the germinating conidia were irradiated, up to 5% of the surviving conidia produced twin colonies, and the recovery of both reciprocal products in twin colonies provided conclusive evidence of mitotic crossing-over. Analogous twin colonies have also been observed following uv irradiation of yeast and ustilago, and thus the effect on recombination may be a general phenomenon. These diploids provide a simple visual screening system for agents that may induce crossing-over. (UK)

8512 MEIOTIC X-Y EXCHANGE AND NONDISJUNCTION INDUCED BY X RAYS IN PRIMARY SPERMATOCYTES OF MALE DROSOPHILA MELANOGASTER. **Wu, Ching-kuei. Providence, R. I., Brown University, 1966. 99p.**

Thesis.

Males bearing the doubly marked Y chromosome, $\underline{B}^S Y\underline{y}^+$, and singly marked Y chromosome, $\underline{y}^+Y$, were x-rayed, in separate experiments, as prepupae and adults, while $Y\underline{w}^+$-bearing males were x-rayed as prepupae only. X-rayed adult males were brooded daily with three virgin females for ten days, and males irradiated as prepupae for four to six days. Untreated males brooded in the same manner served as controls. An increase in the frequency of X-Y exchange and of X-Y nondisjunction was observed in those broods corresponding to the primary spermatocyte stage at the time of irradiation. In all experiments x-irradiation of primary spermatocytes of both immature and mature testes was shown to yield a greater proportion of X-Y exchanges than X-Y nondisjunctionals. The present work confirms Zimmering's preliminary results (unpublished) that after irradiation of the prepupal testis more cases of X-Y exchange than X-Y nondisjunction were recovered. Sävhagen (1961) and Strangio (1961, 1962) have reported that x-rays induce an appreciably higher frequency of X-Y nondisjunction as compared with X-Y exchange in primary spermatocytes of the adult Drosophila melanogaster male. Their conclusion is in disagreement with that arrived at on the basis of the present work. Sävhagen employed the $\underline{y}^+Y$, and Strangio the $\underline{B}^S Y\underline{y}^+$. A closer examination of their experimental schemes suggests that the genetic test used by Sävhagen to distinguish between exchange and nondisjunction may have been faulty, thus providing no basis for a decision as to the relative frequency of occurrence of these events, and the experimental design of Strangio failed to permit the identification of exchanges between X and Y^L, a class constituting approximately 50 percent of all X-Y exchange. However it is difficult to explain why tests that Strangio presumably carried out to distinguish nondisjunction and $X-Y^S$ exchanges gave evidence that most of these cases were nondisjunctionals, since, on the basis of the present evidence, the vast majority of such cases should have proven to be $X-Y^S$ exchanges. On the other hand, the pattern of differential sensitivity of various cell stages of spermatogenesis with respect to deletions, chromosome loss, etc., is in agreement with the work of these and other authors. From experiments in which the doubly marked Y chromosome, $\underline{B}^S Y\underline{y}^+$ was employed, the spontaneous frequency of $X-Y^S$ exchange was higher than that of X-Y nondisjunction. With the singly marked Y, $\underline{y}^+Y$, nondisjunction exceeded exchange. The reason for this difference with the two types of Y chromosomes is not clear, although it may be possible that XXY nondisjunctionals, hyperploid for both $\underline{y}^+$ and $\underline{B}^S$, may be less viable than those hyperploid for y^+ alone, and/or since the $\underline{B}^S Y\underline{y}^+$ carried the $\underline{y}^+$ allele on Y^S, and its associated X-derived heterochromatin, pairing of Xh and Y^S may be facilitated resulting in fewer nondisjunctional cases of X and Y as well as favoring the rejoining of spontaneous breaks leading to exchange. It was observed that the spontaneous frequency of $X-Y^S$ exchange is higher than that of $X-Y^L$ exchange. This result is consistent with Cooper's cytological observation (1964) that Xh pairs with Y^S more frequently than Y^L. On the other hand, approximately equal frequencies of induced exchanges between X and Y^S and X and Y^L were recovered in doubly marked Y experiments. To account for this observation, it may be argued, reasoning by analogy with Parker and McCrone's work (1958) on irradiation of oocytes in female Drosophila, that induced X-Y exchange may occur, in part, at a stage equivalent to Stage seven in the female during which synaptic relationships play the predominant role in determining the sites of exchange, and in part, at a post-synaptic stage where exchanges of X and Y^S and X and Y^L are more likely to be determined largely by the probability of breaks induced in the two arms of the Y chromosome; thus, the increase in Y^L involvement may be due to its longer physical length. It was found that in the doubly marked Y experiments, immature testes treated with x-rays yielded more X-Y exchanges than the treated mature testes. While the possibility cannot be ruled out at present that primary spermatocytes of prepupae are more sensitive to x-rays than those of adult flies, a simpler explanation is that the testes at prepupal stage possess a larger cell population of primary spermatocytes than the adult. It was observed that the spontaneous and induced frequencies of XXY females, as compared with that of XO males and that of X-Y exchange females, are relatively low. The possible bearing of the Peacock and Erickson's hypothesis (1965) on the interpretation of these observations is discussed. (auth)
Disser. Abstr.

Health Physics and Safety

***Refer also to abstracts** 8197, 8198, 8213, 8312, 8331, 8333, 8340, 8390, 8398, 8434, 8458, 8465, 8491, 8496, 8563, 8569, 8595, 8597, 8637, 8677, 8682, and 9415.*

8513 (CONF-670219) CONFERENCE ON DOSIMETRY OF TOTAL-BODY IRRADIATIONS BY EXTERNAL PHOTON BEAMS, OAK RIDGE, TENN., FEBRUARY 23-24, 1967. **Cloutier, R. J.; O'Foghludha, F.; Comas, F. V. (Oak Ridge Associated Universities, Inc., Tenn.). 32p. Dep. CFSTI.**

Papers presented at a conference on the dosimetry of whole-body irradiation in man are evaluated. Techniques of whole-body irradiation using a single beam of 250 KV or 2000 KV x rays, a single beam of ^{60}Co γ radiation, or multiple ^{137}Cs γ sources are described. It is pointed out that the radiation dose received by the patient has been reported in a variety of ways and that institutions may use more than one expression, such as: midtrunk dose, integral dose, average dose, midplane-midbody dose, skin dose, and epigastric dose. Attempts for uniformity in dosimetry of all patients treated with whole-body irradiation at 38 institutions are discussed. Methods for dosimetry are reviewed. It is concluded that national and international standards for the dosimetry of whole-body external irradiation of man should be established. In the interim, it is suggested that the characteristics of the radiation field, the average radiation dose to the target organ, and the method of dose calculation be stated and that indications of non-uniformity in dose distribution be reported. (C.H.)

8514 (CONF-670305) PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM ON THE BIOLOGICAL INTERPRETATION OF DOSE FROM ACCELERATOR-PRODUCED RADIATION, HELD AT THE LAWRENCE RADIATION LABORATORY, BERKELEY, CALIFORNIA, MARCH 13–16, 1967. Wallace, Roger (ed.) (Division of Operational Safety (AEC), Washington, D. C.). 403p. Dep. CFSTI.

Separate abstracts were prepared for 27 papers. Seven papers were previously abstracted and appeared in NSA as 21: 20020, 26242, 28337, 28519, 32738, 34738, and 39623. (B.H.S.)

For abstracts of individual papers see: 8364, 8392, 8433–8435, 8497, 8498, 8515–8526, and 8593–8600.

8515 (CONF-670305–, pp 63-75) FRACTIONAL LINEAR ENERGY TRANSFER. Madey, Richard (Clarkson Coll. of Tech., Potsdam, N. Y.).

The concept of linear energy transfer (LET) was introduced in radiation dosimetry to describe the local density of energy deposition along the path of an ionizing particle. There is a certain fuzziness about the LET concept that arises from the interpretation of the word local insofar as biological radiosensitivity is concerned. It is possible to specify the extent of a local region around the path of an ionizing particle by restricting the energy transferable to the electrons in the atoms of the stopping medium. The fractional linear energy transfer (FLET) is the ratio of the restricted stopping power to the total stopping power. The restricted stopping power of a medium for a charged particle moving at a given velocity is proportional to the total stopping power. The proportionality factor is essentially independent of the velocity of a heavy charged particle if the restricted transfer is equal to the root-mean-square (rms) energy transfer, and it has only a slight dependence on the primary particle velocity if the restricted energy transfer is equal to the mean energy transfer. In these circumstances, the fact that the FLET is insensitive to the velocity of a heavy charged particle means that only a scale factor distinguishes the restricted stopping power from the total stopping power; hence, a biological effect that depends on some function of the total stopping power will have the same functional dependence on the restricted stopping power with energy transfers restricted either to the rms or to the mean energy transfer. (auth)

8516 (CONF-670305–, pp 88-93) DATA FROM VARIOUS OCCUPATIONAL GROUPS. Parker, Howard (California Univ., Berkeley. Lawrence Radiation Lab.).

Radiation accidents and other data obtained from occupational groups are discussed in respect to the broader viewpoint of occupational health. Of particular interest are accelerator-related accidents. The incidents of exposure are low with the bulk of the low-level radiation accidents being attributable to industrial radiography and exposure to medical x rays. The major cause of accidental exposure was concluded to be the mistaken idea that the source is off. (E.R.B.)

8517 (CONF-670305–, pp 94-113) SOME BIOLOGICAL END POINTS OF DOSIMETRIC VALUE DERIVED FROM CLINICAL DATA. Lushbaugh, C. C. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.).

Clinical experience of the past 70 yrs has provided a firm and extensive basis for occupational radiation health programs. From the data collected, more precise dose-response relations have been established. All mammals react in a similar fashion to radiation exposure, differing only in relation to amount of exposure. Accidents usually occur in situations where dosimetry is either nonexistent or clinically useless at best, thus treatment is reactive to the sequence of anatomical and physiological events, which in turn may become biological dosimeters. In this case the physician can make a meaningful, accurate dose analysis from the course of clinically observable events. Skin reactions are exceptionally fruitful in this respect, as are the occurrence of baldness and the permanence of this condition. Prodromal response, a term replacing the narrower term radiation sickness, is also an effective biological dosimeter. The severity of the response is related directly to intensity of exposure. The most quantitative of all biological dosimetry phenomena is the relation between dose and peripheral lymphocyte count, a parameter influenced by dose fractionation and extent of exposure. (E.R.B.)

8518 (CONF-670305–, pp 143-54) RECENT STUDIES AMONG PERSONS EXPOSED TO RADIATION FROM MILITARY OR INDUSTRIAL SOURCES: A REVIEW. Sagan, Leonard A. (Division of Biology and Medicine (AEC), Washington, D. C.).

Therapeutic applications of radiation account for the longest group of persons exposed to radiation. The data available from this group are however, limited in application by the fact that patients are selected, therapeutic modalities affect the results, and the underlying disease influences the results. A smaller, nonclinically exposed group of people (accident victims) provides data not influenced by these factors. Recent studies among persons exposed externally either in industrial accidents or from military sources are reviewed. Forty-four references are cited. (E.R.B.)

8519 (CONF-670305–, pp 155-73) DOSIMETRY AND RBE AT THE ENDS OF PROTON TRAJECTORIES. Bonet-Maury, P.; Kahn, T.; Wembersies, A.; Choquest, R.; Bernet, A.; de Sagey, J.; Cleur, L. (Paris Univ., Orsay (France). Laboratoire Joliot-Curie de Physique Nucleaire).

Mice and cultures of Eschericia coli were irradiated with monoenergetic unidirectional protons at the ends of their trajectories. The results indicated that the RBE retained a value close to 1 exclusive of the increase in LET at the ends of the trajectories. Increases in the RBE at the Bragg peak are explained by the increase in absorbed dose in this region. Absorbed doses in the Bragg peak were determined using dosimeter made of film, LiF, French glass, and Japanese glass. The experiments were conducted in connection with the hazards existing near accelerators, in space flight, and with respect to fundamental radiobiology. (E.R.B.)

8520 (CONF-670305–, pp 192-6) CONTRIBUTION OF BIOLOGY TO STANDARDS OF RADIATION PROTECTION. Nabrit, Samuel M. (Atomic Energy Commission, Washington, D. C.).

A semihistorical review is given of the contributions of radiobiology to the overall field of radiation. The influence of the radiobiologist is seen not only in the contributions to basic cellular and molecular studies, but also in the establishment of biological parameters that can be utilized by the allied disciplines in nuclear science. Emphasis is given to two new research tools for the radiobiologist; the Omnitron accelerator at Berkeley, and the Meson Physics Facility to be constructed. (E.R.B.)

8521 (CONF-670305–, pp 269-76) DOSE ESTIMATION IN THE CONTEXT OF HEALTH PHYSICS REGULATIONS AND RESPONSIBILITIES. Snyder, Walter S. (Oak Ridge National Lab., Tenn.).

The role of the health physicist as a professional man is discussed in relation to his function to establishing health safety regulations and in protection of personnel. Particular attention is given to the estimation of radiation doses to various tissues as outlined by ICRP regulations and to the contributions to safety above and beyond the letter of these regulations. (E.R.B.)

8522 (CONF-670305–, pp 277-9) RADIATION ENVIRONMENT PARAMETERS AND THE BIOPHYSICIST. Lyman, John T. (California Univ., Berkeley. Lawrence Radiation Lab.).

The role of the biophysicist in dosimetry of accelerator produced radiation in biological material is discussed. The importance to dosimetry of data concerning types of radiation, angular and energy distributions, effective source size, distance from source to object, filtration, specification of target, and time factors is indicated. (E.R.B.)

8523 (CONF-670305–, pp 280-8) ROLE OF CELLULAR RADIOBIOLOGY IN RADIATION PROTECTION. Rossi, Harald H. (Columbia Univ., New York. Radiological Research Lab.).

The influence that cellular radiobiology on the formulation of radiation protection regulations is discussed. The variables involved in determining biological effects are of two types: biophysical parameters such as dose, dose rate, and radiation quality, and biological parameters such as fraction of organ irradiated, organ radiosensitivity, age, and individual variability. Each set of parameters is subject to strong mutual interactions that complicate an estimation of RBE and establishment of radiation protection standards. Data from the RBE committee of the ICRP and the ICRU are presented. (E.R.B.)

8524 (CONF-670305–, pp 306-17) DOSE FROM HIGH-ENERGY RADIATIONS AT AN INTERFACE BETWEEN TWO

MEDIA. Turner, J. E.; Anderson, V. E.; Wright, H. A.; Snyder, W. S.; Neufeld, J. (Oak Ridge National Lab., Tenn.).

Build-up at an interface between two media is important for the interpretation of radiation dose. Therefore results of studies of dose from high energy protons and neutrons at an interface between soft tissue and bone are reported. Because of their different atomic compositions, the contribution to dose from nuclear interactions in the two media is different. By using the Monte Carlo technique, calculations were made of the dose from nucleons with energies of 100 and 400 Mev in two phantoms composed of bone and soft tissue parts. One phantom was a cylinder, having a diameter of 2.5 cm and a length of 8 cm, made in three concentric annular rings, the middle ring containing bone. The other phantom was a 20 × 31 × 60 cm soft tissue parallelepiped with a solid bone center. With 400 Mev nucleons incident laterally on the cylinder the build-up of dose equivalent in going from the outside to the inside of the cylinder appeared to be increased somewhat when the middle annular ring was made of bone rather than soft tissue. A decrease in the quality factor of 400 Mev neutrons from ≈ 8.6 to ≈ 6.5 was found in the middle ring when soft tissue was replaced by bone. In the parallelepiped, the presence of the bone center, rather than soft tissue, apparently made little difference. (auth)

8525 (CONF-670305–, pp 318-28) TECHNIQUES IN DOSIMETRY AND PRIMATE IRRADIATIONS WITH 2.3-BeV PROTONS. Williams, G. H.; Parker, C. V.; Nelson, J. B.; Morgan, I. L. (Texas Nuclear Corp., Austin); Mitchell, J. C.; Hardy, K. A. (School of Aerospace Medicine, Brooks AFB, Tex.).

The physical experimentation and dosimetry involved in the whole-body irradiation of the primate Macaca mulatta with 2.3 BeV protons obtained from the Cosmotron facility at the Brookhaven National Laboratory are described. The work is part of a study involving whole-body exposures of the primate to protons of various energies in the range 32 MeV to 2.3 BeV. By extension, the effects of ionizing radiation on man and possible hazards experienced by extended travel in space can be estimated. The physical aspects, dosimetry, and resultant biological effects were previously reported for exposures to protons of 32 MeV, 55 MeV, 138 MeV, 250 MeV, and 400 MeV. A total of 117 primates were irradiated with doses ranging from 28 to 3400 rads. The basic dosimetry measurement was the integrated proton flux incident on the animals. The flux was then related to average body dose in rads by making exposures of glass and lithium fluoride microdosimeters embedded in primate phantoms. Measurements indicated that the rad dose received by the animals was 43% higher than that based on the stopping power of the incident protons alone. The primates were exposed while in a horizontal position parallel to the beam axis, half the total proton flux being incident on the head, and half incident on the feet. Biological results of the exposures are briefly reported. (auth)

8526 (CONF-670305–, pp 382-90) USE OF CHROMOSOME ABERRATIONS FOR DOSIMETRY. Norman, Amos (California Univ., Los Angeles. Dept. of Radiology).

Recent work indicated that the frequency of chromosome aberrations in lymphocytes taken from peripheral blood may be used as a measure of absorbed dose. The problems involved in making this estimation are discussed. Deletion type aberrations vary linearly with dose, whereas dicentric aberrations and rings increase as the square of the dose when protons are the radiation source. Numbers of rings and dicentrics are a linear function of neutron dose. As radiation dose increases, the number of cells free of aberrations decreases, but this has no relation to reproductive death. Reliability of dosimetry by chromosome aberrations is limited at low doses by the low incidence of aberrations. A relation between frequency of chromosome aberrations and leukemia is suggested. (E.R.B.)

8527 (SC-DC-67-2191) REVIEW OF SANDIA "SYMPOSIUM ON INSTRUMENTATION, EXPERIENCE, AND PROBLEMS IN HEALTH PHYSICS TRITIUM CONTROL." Rarrick, Harold L. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 7p. (CONF-671018-1). Dep. CFSTI.

From Meeting of the American Public Health Association, Miami, Fla.

Papers presented at a conference on the control of tritium hazards are evaluated. It is pointed out that tritium is a hazard to man only when it enters the body. Tritium in the form of a gas does not present a serious health problem except in large quantities, but small quantities of tritium in soluble form (water, oil, salts) present a serious health hazard. Instrumentation is available for the monitoring of tritium except for areas having high γ or x ray backgrounds. The performance of ionization chambers and vibrating reed electrometers for the measurement of β activity from tritium in air, and the efficiency of protective equipment, such as protective clothing and respirators, are discussed. It is recognized that tritium is becoming a more widely used isotope for tracer experiments, and, as such, is entering the domain of Public Health. (C.H.)

8528 (JPRS-42929, pp 208-65) MEANS OF PROTECTION AGAINST MASS-CASUALTY-PRODUCING WEAPONS. Translated from pp 189-242 of Kratkoe Rukovodstvo po Toksikologii, Meditsina Publishing House, Moscow, 1966.

Methods for protection against mass-casualty-producing weapons, toxic agents, radioactive agents, and bacteriological weapons include use of filter-equipped gas masks, insulating gas masks, protective clothing, and shelters. Ventilated and non-ventilated facilities are described. (H.L.W.)

8529 (JPRS-42929, pp 293-330) RADIOACTIVE CONTAMINATION DURING NUCLEAR EXPLOSIONS. RADIATION RECONNAISSANCE. RADIOMETRIC AND DOSIMETRIC MONITORING. Serdyuk, D. S.; Sashkov, E. V. Translated from pp 266-301 of Kratkoe Rukovodstvo po Toksikologii, Meditsina Publishing House, Moscow, 1966.

Characteristics of radioactive contamination of the terrain are discussed. The bulk of radioactive substances are fission products of uranium and plutonium; their quantity depends on the explosive capacity of the nuclear weapon and the location of detonation. In the region of the aerial explosion epicenter, radioactive contamination is by radioisotopes of Si, Al, Mn, and Na; half-lives are short. In the case of surface nuclear explosions, contamination is extremely widespread. The most dangerous of the long-lived radioisotopes are ^{90}Sr and ^{137}Cs. Underground explosions are followed by contamination of the terrain in the region of the crater; such contamination is much greater than that of the surface explosions. General features of injuries caused by gamma radiation, beta particles, and alpha emitters are discussed. Units of measurement of radioactivity are listed and defined, and methods of radiation detection are described. Dosimeters used by personnel for radiation reconnaissance are discussed. Methods for monitoring of radioactive contamination and dosimetry are presented. A radiometric laboratory for measuring contamination of foods and objects in the environment is described. (H.L.W.)

8530 (JPRS-42929, pp 331-58) CHEMICAL AND RADIOACTIVE DECONTAMINATION. Translated from pp 301-23 of Kratkoe Rukovodstvo po Toksikologii, Meditsina Publishing House, Moscow, 1966.

Mechanical, physical, and chemical methods of chemical decontamination are defined. Chemical properties and uses for chemical decontaminants are tabulated. Examples of decontaminants used are chlorinated lime, calcium hypochlorite, dichloramine T, hexachloramine, and monoethanolamine. Methods of radioactive decontamination of battle gear and other materials include flushing with water or decontaminating solutions or rubbing of contaminated surfaces with rags, fiber packing, or bunches of straw soaked in water. Radioactive decontamination of terrain is accomplished by removing the surface layer of soil, upturning the soil, or covering the soil with an uncontaminated layer of soil. The following aspects of decontamination are also discussed: chemical and radioactive decontamination of gear, uniforms, underwear, footwear, and means of antichemical protection; instruments and facilities used for the chemical and radioactive decontamination of clothing and gear; decontamination of medical and hygiene facilities; chemical and radioactive decontamination of water under field conditions; and safety measures during the performance of chemical and radioactive decontamination under field conditions. (H.L.W.)

8531 HANDLING OF INFORMATION ON RADIATION PROTECTION. de Robien, E. (Centre d'Etudes Nucleaires, Grenoble, France). Energ. Nucl. (Paris), 9: 323-9(Aug.-Sept. 1967). (In French).

The problems of protection encountered since the discovery of x rays are the same today, however, the means of handling them are improved. As the number of men to protect is higher, it is important to give the alert automatically in case of contamination, and to centralize the electronic devices or, if this is not possible, to have alarms in each building. Keeping within the standards is only possible by measuring the total dose, which is inconvenient because no alarm is given in case of over dosage, whereas measuring the total dose given off by conventional apparatus is an expensive electronic operation. Transistorization already leads to more reliable results and a complete electronic system ought to provide even better results in this field. (auth)

8532 BODY BURDENS OF ^{137}Cs IN TORONTO IN 1964–1967. McNeill, K. G.; Harrison, J. E. (Univ. of Toronto). Nature (London), 216: 1340-41(Dec. 30, 1967).

Previous data indicated that the body burdens of ^{137}Cs due to fall-out appeared to have passed a maximum of 23.7 nCi in the winter of 1963-64. Later data, covering 1965 to 1967, are reported in this communication. The most recent figure (summer 1967) for the average body burden of sample subjects was 6.7

nCi. Data are also given for average body K and the ratio ^{137}Cs/K. The data confirm that a maximum was reached in 1963-64, and that the current levels are approximately those obtained before the results of the 1961 bomb tests were noted. It appears that the period of halving the caesium body burden is about a year, and this is presumably related to the residence time of fission products in the stratosphere. Some data are also given on the difference of Cs/K ratios in the sexes. (UK)

8533 FALLOUT AND STRONTIUM. Brit. Med. J., 2: 325(Aug. 5, 1967).

The continuing program in the United Kingdom to monitor ^{90}Sr levels in humans and its results are briefly reviewed. Surveys began in Great Britain in 1955 and are now conducted by two groups (the Capenhurst laboratories of the United Kingdom Atomic Energy Authority, and Glasgow), that analyze more than 400 bone samples a year. The concentration of ^{90}Sr in bone is greater in children than in adults. The level of contamination rose to a peak in 1959 and declined slowly for three years before rising to another maximum in 1964 and 1965. The latest report, covering the first half of 1966, shows that levels of ^{90}Sr in bone continue to decline slowly, though remaining higher than at any time before 1964. Arrangements for the analysis of human bone samples were altered. Until now the femur was used in the British program, but vertebrae were analyzed in most other countries. The difference is not important for infants, children, and adolescents, for whom little variation was found in ^{90}Sr levels among the bones of the skeleton. In adults, however, its concentration in vertebral bone is two to three times greater than in the femur. It was decided that the United Kingdom Atomic Energy Authority team will now use vertebrae for analysis. The Glasgow group, whose work is confined mainly to study of samples from subjects under five years of age, will continue to analyze femora. At present, levels of ^{90}Sr in human bone do not give cause for serious anxiety in regard to radiation hazards, but valuable information is emerging from comparisons with other countries, where diet and weather conditions lead to differences in uptake of radioactive fallout. (BBB)

8534 DESIGN OF X-RAY PROTECTION EQUIPMENT FOR DIAGNOSIS IN PREMATURE INFANTS AND THE MEASUREMENT OF RADIATION DOSES. Imada, H.; Kato, D.; Ishigaki, M. (Tohoku Univ., Sendai). Seikei Geka, 16: 542-5(May 1965). (In Japanese).

For protection against excessive x-ray exposure of premature infants in radiodiagnostic studies, some shielding equipment was designed. This included a 5-mm thick shield, to cover ovaries or testes, which was attached to a stage which held the patient. A lead plate covered the back of the stage to avoid backscatter. With such equipment, the gonads of the patient were well protected during x-ray exposure. The measurement of radiation doses was conducted under the following conditions: a 2-month-old infant was radiographed with 40 KV x rays, at 100 mR for 0.1 sec, over the lower abdomen and the dose was measured with a Toshi pocket chamber, SDP-54103 type. The results demonstrated the protective effect of the equipment, and this could be improved by increasing the thickness of lead plate. The patient as well as the examiner were well protected from excessive irradiation. The tissues of premature infants are even more sensitive to radiation than those of normal infants or adults, and the average frequency of x-ray exposure in premature infants is 10 times higher in males and 12.5 times higher in females than full-term infants. Such repeated x-ray exposures require that the gonads be well protected. (BBB)

8535 THE DETERMINATION OF IODINE ISOTOPES IN PLANTS. Zaduban, Milan; Brutovsky, Milan; Liptakova, Gizela; Vinklerova, Olga (Ustav Experiemntalnej Biologie, Kosice, Czech.). Biologia (Bratislava), 21: 578-88(1966). (In Slovak).

The measurement of ^{131}I in plants, with or without chemical preparation was studied. Methods for extraction of ^{131}I, purification by ion exchange, and sample preparation are described. Characteristics of measurement instruments and techniques are described. Step-by-step procedures are outlined for the chemical procedures. The use of ultrasonic treatment to prepare the radioactive samples at temperatures of less than 100°C is recommended. The methods described are shown to be highly effective for sample preparation, are simple, and are particularly well suited for serial analyses. (BBB)

8536 RADIATION HAZARDS IN NUCLEAR POWER PLANTS. Janssen, Udo (Institut fuer Reaktorphysik der Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht-Tesperhude, Ger.). Lebensversicherungsmedizin, 18: 133-5 (Oct. 4, 1966). (In German).

The present and future use of atomic power plants in Germany is briefly received. Reactor types, locations, fuels, moderators, coolants, and power outputs are tabulated. The irradiation burden of personnel who work in atomic power plants in the U.S.A. is tabulated in terms of levels of dose received, ranging from 0 to 1 rem/yr to more than 15 rem/yr. During the years 1959 to 1962 about 95% of the personnel received the lowest irradiation, 4 to 5% received from 1 to 5 rem/yr, and only small fraction of 1% received from 5 to more than 15 rem/yr. It is concluded that although accidents cannot be entirely excluded, the irradiation safety procedures in use are extensive enough that exposure to high irradiation levels is unlikely for either those employed in atomic power plants or for the general population. (BBB)

8537 PELVIC ARTERIOGRAPHY IN TOXEMIA OF LATE PREGNANCY. Pystynen, P.; Rainio, J.; Voutilainen, A.; Rytila, A.; Jarvinen, P. A. (Univ. of Oulu, Finland). Acta Obstet. Gynecol. Scand., 45: Suppl. 9, 86-95(1966).

Dosimetry studies were conducted to evaluate possible hazards of x irradiation to the fetus in the course of pelvic arteriography. The series consisted of 11 patients with severe pre-eclampsia, 6 with mild pre-eclampsia, and 10 control subjects. About 30 ml of 60% Urografin was introduced via catheter into the aorta, and the first radiogram was taken during, the second immediately on completion of, and the third about 4 sec after, the injection. A fourth exposure was made 0.5 sec later. The dose of irradiation received by the fetus was estimated by measuring the dose at rectum, using ionization chambers. For this purpose, 25 radiograms were taken of different subjects. The dose of irradiation at rectum per radiogram was about 16 mR. During one examination the fetus was calculated to receive a total dose of about 0.2 R over the entire body. The method can probably also be used routinely to estimate the degree of severity of toxemia. Since the condition is one that affects both maternal and fetal vitality, this dose (0.2 R) is probably not so high as to contraindicate the method. It complies with the recommendations of ICRP (International Commission for Radiological Protection), according to which no absolute ceiling limit of the dose can be stipulated, and medical indications decide the issue. The value of the examination is not much less if only 2 exposures are made; in this way the fetal dose will only be 0.1 R. (BBB)

8538 INHALATION INOCULATION OF RATS WITH UNSEPARATED SOLUTION OF URANIUM FISSION PRODUCTS. Perov, V. S.; Tregubenko, I. P.; Semenov, D. I.; Kach, A. Z.; Strel'tsova, V. N. Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial, No. 46, 41-7(1966). (In Russian).

An apparatus for dynamic inoculation of small laboratory animals with radioactive aerosols obtained by mechanical atomization of solutions was designed and constructed. The apparatus, made of organic glass and providing for air exchange at the rate of 900 L/hr, ensured constant aerosol concentration in the air and made it possible to fairly accurately determine the amount of radioactivity inhaled by the animals; relatively small contamination of the animal skin occurred. Tests on rats using an unseparated solution of emitters (containing mostly ^{106}Rh$-^{106}$Ru and ^{90}Sr$-^{90}$Y) and dispersed at an average particle diameter of 1 to 4 μ showed reproducible results. Orientation experiments helped establish the behavior of the emitter in rat organisms after its inhalation in aerosol form. The overall radioactivity of the rats was reduced within a month from 50 to 5%; these values were approximately the radioactivity of the skeleton from which the isotopes were eliminated very slowly. (ATD)

8539 THE ROLE OF CLAY IN ^{90}Sr AVAILABILITY TO PLANTS. Yudintseva, E. V.; Gulyakin, I. V.; Folomkina, Z. M.; Kozhemyakina, T. A. (Moscow Biophysical Lab.). Agrokhimiya, No. 8, 100-7(Aug. 1967). (In Russian).

The results obtained show that the slimy fractions of soils play a big role in the decrease in the availability of ^{90}Sr to plants and its accumulation in harvests. The increase of the quantity of clay in turf podzolic medium-clayey soil can significantly decrease the concentration of radiostrontium in the straw of plants and somewhat decrease its accumulation in the grain. The addition of either clay or soil, containing increased quantities of this fraction to light sandy soil can sharply decrease the accumulation of strontium-90 both in the straw and in the grain of the plant. Such an effect of the clay fraction caused a very stable fixation of the radiostrontium in clay. The supplementary soil and clay fractions of this soil absorbed 91.5 and 90.1%, respectively, of the quantity introduced and 91.9 and 70.9% of the absorbed quantity were displaced by 0.5$\underline{N}$ solutions of calcium chloride from the soil and clay, respectively. (tr-auth)

8540 RADIATION DOSIMETRY IN RELATION TO HIGH INTENSITY RADIATION SOURCES. Jarrett, R. D. Jr. (Army Natick Labs., Mass.). pp 78-86 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16-17, 1965. See CONF-650902.

A dosimeter suitable for measuring the radiation intensity at doses in the range of 10^4 to 8×10^5 rads consists of a solution of 0.001M ferrous sulfate – 0.01M cupric sulfate in 0.010N sulfuric acid. If the recommended concentrations are used, the dosimeter is reproducible to ±0.3% and stable after irradiation to approximately 2% per week. The dose received by the recommended dosimeter can be calculated, if read at 25°C, by converting the change in absorbance (ΔA) using the equation: dose (rads) = $\Delta A \times 6.43 \times 10^5$. This solution may be stabilized against thermal changes by preirradiating the solution of approximately 10^5 rads. This solution is then stable, changing approximately 2% per week. (auth)

8541 APPLICATION OF COMPUTERS IN THE DETERMINATION OF THE DOSE IN RADIOTHERAPY. Richter, J.; Penchev, P. Rentgenol. Radiol., 5: 212-17(1966). (In German).

Procedures for the determination of doses from linear radioactive sources of γ-rays by means of computers are described. Programming of the computer by the procedure proposed made it possible to determine the dose without considering absorption and scattering by the filter and tissues, by considering the interaction of the radiation with either the filter or tissues, and by considering the effect of both the filter and tissues. The program is applicable for any radiation source and at any activity of the source, energy of radiation, active length of radioactive preparations, and thickness of filters. Examples of calculation of the distribution of the dose in connection with application of moulage or a radioactive isotope implant are given. The results obtained were found superior to those obtained by the use of Paterson and Parker's tables. The particular advantages of applying the procedure in connection with interstitial γ-therapy are pointed out. (JPRS)

8542 LETHAL DOSE OF MICE IRRADIATED THROUGH A SIEVE OF TWENTY PERCENT SHIELDING. Sakamoto, Kiyohiko (Tokyo Medical and Dental Univ.); Sakka, Masatoshi Nippon Igaku Hoshasen Gakkai Zasshi, 27: 125-8(May 1967).

Albino mice were irradiated with x rays through a lead sieve of 20 percent shielding. Conventionally irradiated mice were used as a control. An increase in lethal dose was noted in sieve irradiation and a possible mechanism of this protective effect was discussed. (NSA of Japan)

8543 FOOD AND RADIATION PROTECTION. Merten, D. (Bundesversuchs- und Forschungsanstalt fuer Milchwirtschaft, Kiel). Bibl. Nutr. Dieta, 9: 24-31(1967).

Mechanisms by which fallout radionuclides enter the human diet are examined along with countermeasures that can be used to reduce such intake. In 1964, the rate of fallout was about 40 pCi/day/m^2 ^{90}Sr, and the total intake of ^{90}Sr in the same period was about 40 pCi/day/person in some western countries. About 3000 m^2 of arable land is required for producing 1 person's food, and the total amount of ^{90}Sr deposited on that area is ~120 nCi/day; thus highly effective barriers exist between fallout and food, resulting in an over-all reduction factor of about 3000. The radioactive material reaching the soil from the atmosphere is practically free of carriers, i.e. it is present in the soil in extremely small amounts; 40 pCi ^{90}Sr equals ~10^{-12}g. The ^{90}Sr concentration in soil, therefore, is far below the solubility index. Thus, the artificial radionuclides do not undergo precipitation, but due to interference from other soil constituents, they can be co-precipitated or occluded. Furthermore, they can undergo adsorption and ion exchange processes. Radiocesium, e.g., is strongly fixed by the mineral illite and is almost unavailable for root uptake. Liming of soil can reduce radiostrontium root uptake considerably, as can deep plowing. Radionuclides fixed by ion exchange can partly be removed from plants by washing with water, diluted acids, or solutions of chelates. For cereals, about 20 to 40% of ^{90}Sr can be removed by washing. The aerial parts of plants are protected against contamination by hydrophobic surfaces, so that contamination of fodder and food can be reduced considerably by eliminating plants or its products with hydrophilic surfaces. Ideal plants from the point of view of low Sr contamination should have a high rate of growth and hydrophobic surface and be rich in Ca. Also discussed is the use of inorganic and organic chemicals such as sulfates, oxalates, phytates, and alginates, which reduce absorption by forming insoluble or complex Sr complexes. (BBB)

8544 RADIOLOGICAL HAZARD EVALUATION OF ATMOSPHERE IN THE URANIUM MINE, BASED ON THE DETERMINATION OF "f" VALUE. Fusamura, Nobuo; Kurosawa, Ryuhei (Waseda Univ., Japan). Waseda Daigaku Ribogaku Kenkyusho Hokoku, No. 36, 141-53(Sept. 1966).

The f value is an important factor for estimation of the radiation hazard due to the inhalation of radon and its daughter elements. The diffusion coefficient is very large for ^{218}Po unattached to condensation nuclei. When air containing ^{218}Po is flowed through a cylindrical tube, a considerable part of the ^{218}Po deposits on the inside of the tube. Apparatuses for measuring this amount of deposited ^{218}Po and for determining the f value were constructed, and a relation between the flow rate and tube length and the deposited amount were examined. The value of f was measured for the air in several uranium mines in Japan, using the apparatuses. Although results differed among the mines, depending on the particular apparatus, the f values were 0.07 to 0.8. The diffusion coefficients of deposited particles were near the usual values. (NSA of Japan)

8545 THE LOG-NORMAL FUNCTION AS A STOCHASTIC MODEL OF THE DISTRIBUTION OF ^{90}Sr AND OTHER FISSION PRODUCTS IN HUMANS. Schubert, Jack (Univ. of Pittsburgh); Brodsky, Allen; Tyler, Sylvanus. Health Phys., 13: 1187-1204 (Nov. 1967).

Data on the concentrations of ^{90}Sr, ^{226}Ra, ^{137}Cs, and some of the stable trace elements in human tissue as well as environmental samples, have been found, without exception, to follow log-normal distributions rather than normal distributions. Also, while the median of the ^{90}Sr concentration in human shifts for different time periods, areas of the world, and population age distributions, the geometric standard deviation has seemed recently to remain within the relatively narrow range of 1.55 – 1.67 for large population groups, so that about the same proportion of each population contains concentrations in excess of a given multiple of the median (or the average) concentration. The log-normal distribution fits the data better than the normal distribution, particularly in the "tail" of higher concentrations. This is the region most critical for the evaluation of the proportions of the population exceeding recommended limits of individual exposure. The repeated suitability of the log-normal permits the recommended limits of individual exposure. The repeated suitability of the log-normal permits the recommended limits of environmental contamination to be established with more confidence in predicting the proportions of the population exceeding any given level. The 1964 – 1965 U. S. Public Health Service measurements of ^{90}Sr in the bones of U. S. children and young adults give parallel cumulative log-normal lines for the ^{90}Sr concentration per gram of bone and per gram of calcium. These lines have approximately the same slope as Kulp and Schulert's distribution for the variations in ^{90}Sr concentration in total skeletal bone between adults in New York City in 1958, and the same slope as the distribution for stable strontium, indicating a characteristic variance in the log-normal distribution of strontium in bone within a limited geographic region. The average of the United States distribution in children and young adults was about 3.5 μμCi ^{90}Sr/g calcium in October, 1964 – March, 1965, the equilibrium level of 3.5 μμCi/g predicted by Kulp and Schulert for 4 – 5 yr following the 1961 Soviet tests. The log-normal line fitted to the 1964 – 1965 U. S. data indicates that less than 3.6% of the United States population of age less than 25 will have bone doses exceeding twice the average. Extrapolation of the log-normal distribution would indicate that less than 0.36% of the population under age 25 would exceed 10.4 μμCi ^{90}Sr/g calcium (3 times the average). The same percentages would apply to the corresponding multiples of average ^{90}Sr concentration per gram. The applicability of the log-normal function for estimating internal, and possibly external, exposure distributions in the world population is also discussed. (auth) (UK)

8546 ISODOSE CHARTS FOR CURVED SURFACES IN TELECOBALT AND TELECESIUM THERAPHY. Debois, J. M. (Univ., St. Rafael, Leuven, Belg.). Acta Radiol., Ther., Phys., Biol., 6: 233-40(June 1967).

Isodose charts for curved surfaces irradiated with telecobalt and telecesium beams were prepared by measurements with an automatic isodose plotter beneath a convex surface in a water phantom. The values thus obtained were compared with the theoretically determined values. (auth)

8547 MEASURING DEVICE FOR THERMOLUMINESCENCE DOSIMETRY. Lindskoug, B.; Johansson, M.; Karlsson, R.; Kellgren, R. (Sahlgrenska Sjukhuset, Goteborg). J. Sci. Instrum., 44: 939-42(Nov. 1967).

In radiobiological work there is a need for very narrow measuring probes that can be inserted in small cavities. A radiation dosimeter utilizing the thermoluminescent properties of LiF was developed for the purpose. Permanently filled containers are used. The container material is Teflon, which stands the temperature needed for read-out. The outer diameter of the Teflon tube is 1.5 mm and the wall thickness is 0.25 mm. The dosimeter consists of 10 mg of LiF powder enclosed in the Teflon tube. It is reused several times and the read-out is made without unloading the powder. Each probe contains a number of small dosimeters, so that measurements are obtained at several points simultaneously. The specially built read-out device is described in detail. It is at present being used for measurements in patients. (auth)

8548 DOSE DISTRIBUTIONS AS A FUNCTION OF LET AND MEASUREMENTS OF QF AROUND THE BNL MEDICAL RESEARCH REACTOR. Phillips, L. F.; Scalsky, E. D.; Champagne, R. J. (Brookhaven National Lab., Upton, N. Y.). Health Phys., 13: 1175-86(Nov. 1967).

Measurements were made by the use of a Rossi-Type LET spectrometer. This spectrometer, as presently utilized at BNL, consists primarily of a 4 in. dia spherical tissue-equivalent proportional counter used in conjunction with a tissue equivalent ionization chamber. Effective QF values observed in the work areas outside of the reactor experimental facilities varied from 1.3 to 5.8. The lowest value was found in the more distant reactor console area, and the highest value was measured at a steel door where the quantity of moderating material is minimal. QF values of 3.1 and 6.2 were measured in two experimental beams. The higher QF value resulted from the presence of a Cd filter in one of the beams, which otherwise were quite similar. LET spectra measured as a function of depth in a crude paraffin phantom placed in these beams indicated QF values ranging from 3.2 (at the surface) to 1.7 in one beam and 6.0 to 2.2 in the Cd filtered beam. In all LET spectra for which QF values were well above unity the dose in the proton Bragg peak region (approximately 100 keV/μm) was significant. In the presence of thermal neutrons a broad peak, due to the $^{14}N(n,p)^{14}C$ reaction in tissue, occurred in the LET spectrum around 50 keV/μm. (auth) (UK)

8549 INTERCOMPARISON OF THE RELIABILITY OF BODY ^{137}Cs MEASUREMENTS ON HUMAN BEINGS. Maletskos, Constantine J. (Harvard Medical School, Boston); Dean, Phillip N.; Lough, S. Allan; Miller, Charles E. Health Phys., 13: 1307-19(Dec. 1967).

As a result of large variations in the ^{137}Cs body burdens reported by participating laboratories, the Division of Biology and Medicine, USAEC, appointed a committee to conduct an intercomparison between these laboratories on the reliability of body ^{137}Cs measurements on human beings. The intercomparison was divided into three phases: (1) intercomparison with National Bureau of Standards ^{137}Cs sources to determine variations in the absolute activity of the laboratory standards and to place the laboratories participating in this study on a common basis for future work; (2) determination, at three different distances from the detector, of the ratio between three ^{137}Cs sources with nominal activities of 1000, 100 and 10 nCi, i.e. between a decade set, to assess the ability of each laboratory to account for all the physical and electronic variables in measurements conducted with whole body counters; and (3) determination of the ^{137}Cs body burdens of two well-documented subjects (one with a "normal" burden and the other with a burden ~10 times greater) by the usual procedure of each laboratory, to assess the reliability of calibration factors and the control of physiological and other physical variables. Each laboratory supplied information in the same form, in order to make the evaluation consistent and convenient. Each participating laboratory compared the old value of its working standard to a new value based on reference to the certified NBS standard. The average of the ratios of new to old value was 1.01 ± 0.04. The ratios of the participating laboratories' values for the decade sources to the corresponding Argonne National Laboratory values averaged 1.00 ± 0.01, for each of three source to detector distances. The ratios of the body burdens found to the values reported by the Los Alamos Scientific Laboratory averaged 0.96 ± 0.11 for the high ^{137}Cs burden, and 0.93 ± 0.13 for the low ^{137}Cs burden. Averages of similar ratios for body potassium were 0.93 ± 0.08 (high burden) and 0.90 ± 0.06 (low burden). The conclusion is that these laboratories can be capable of reliable ^{137}Cs and K body measurements in human beings. Differences which occur in such body measurements appear to be associated with physiological variables (affecting calibration factors, for example) rather than with physical or electronic variables. In view of these results it is not clear why the original results were so variable. Since that time, the normal ^{137}Cs burdens have increased, instrumentation has improved, a greater attention has been devoted to calibration factors, and each laboratory has gained much experience. Any or all of these factors have probably contributed to the state of the art which has been demonstrated by the intercomparison. (auth)

8550 ON THE CONNECTION BETWEEN THE PHYSICAL, CHEMICAL, AND BIOLOGICAL STRUCTURE OF THE SURFACE LAYER OF WATER OF THE BLACK SEA. Bogorov, V. A.; Kolesnikov, A. G.; Demenitskaya, R. M.; Gorodnitskii, A. M.; Kokin, K. A.; Konstantinov, V. P.; Paramonov, A. N.; Ushakov, S. A.; Fedorov, V. D. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 172: 1187-90(1967). (In Russian).

Investigation of physical features in the northern part of the Black Sea, with supplementary chemical and biological data, shows the close connection and interaction between these parameters. The study was conducted by several scientists in May and June, 1966 aboard the research ship Moskovskiy universitet. At each of 29 stations, measurements of pH, electric field (pS), turbidity (B), radioactivity (R), and temperature (t) were made, and samples were taken for biological and hydrochemical analysis, including analysis of H_2S, CO_2, plankton, and saprophytic bacteria. The variation of pH, pS, H_2S, and CO_2 with depth is graphed. The pH curve shows a slight acidification at 100 m due to a shift in the equilibrium of the carbonate system with an increase in free CO_2; a jump at 190 to 200 m due to specific reactions between ions of H_2S and the antimony electrode; and acidification in lower regions due to microbiological oxidation of sulfides with the formation of the $SO_4^{=}$ ion. The pS curve shows a peak in the surface zone due to a concentration in microorganisms; laboratory experiments show that the effect is stronger for microorganisms than for zooplankton. A second peak is attributed to the reaction of lead electrodes with ions of H_2S. The turbidity and radioactivity curves show that three peaks in turbidity are present: the first due to concentration of phytoplankton, the second due to concentration of zooplankton, and the third due to concentrations of "bottom" phytoplankton and fecal pellets of zooplankton, present because of strong ascending currents. Corresponding peaks in radioactivity are found, and an analysis of the differential γ-ray spectra shows an increased content of ^{137}Cs and ^{144}Ce, due to selective accumulation by plankton organisms. (ATD)

8551 PENETRATION PARAMETERS FOR 15-MeV NEUTRON BEAMS. Broerse, J. J. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Kerntechnik, 9: 446-51(Oct. 1967).

The shielding measurements are reported that yield adequate information on the attenuation characteristics of different materials. The results are of importance for the radiation protection of neutron generators. Our experiments on the penetration into phantoms and the collimation characteristics of different materials are still in progress. More detailed information on these subjects must be obtained in view of the possible clinical application of fast neutrons for radiotherapy. (auth)

8552 STUDIES ON BONE-SEEKING RADIOISOTOPES. Rowland, R. E. (Argonne National Lab., Ill.). Excerpta Med. Int. Congr. Ser., No. 105, 1530-6([1966]).

Current knowledge of the radiation dose delivered to man by his surroundings is reviewed. Data are tabulated on the total skeletal dose from external sources, cosmic rays, and γ rays originating in the earth's surface, as well as from the internal sources, the natural radioelements found in the skeleton such as ^{14}C, ^{40}K, and ^{226}Ra, ^{228}Ra, and ^{210}Pb and their daughters. The dose was calculated as that delivered to a layer of cells, 10 microns thick, adjacent to bone surface during one year. Higher doses will be obtained if the dose delivered to the bone mineral itself is considered, but as this type of calculation is probably not of value, this discussion is restricted to the dose-rates delivered to these bone cells. When the contributions to the bone cell dose from internal sources are examined in detail, it is found that the beta-emitting isotopes present in high concentration, ^{14}C and ^{40}K, account for somewhat less than half the total. The alpha-emitting daughters of the radium series contribute more than half the total bone cell dose-rate. For these calculations, an RBE of 10 alpha particles was used, as suggested in the 1962 Report of the United Nations Scientific Committee on the Effects of Atomic Radiation, following the recommendations of the International Commission on Radiological Protection. (C.H.)

8553 NEW EXPERIMENTAL RESULTS CONCERNING THE DECONTAMINATION OF WORKING CLOTHES. Boenzi, D.; Branca, G. Riv. Ing. Nucl., 3: 807-14(May-Aug. 1965).

A review is presented of methods used for the decontamination of clothing worn by workers in nuclear industry. Results obtained in identical experimental conditions using a made-up decontaminant mixture (consisting of equal parts of sodium lauryl sulfate, Antarox DM-970, sodium hexametaphosphate, sulfosalicylic acid and sodium nitrate), and using brand-named products are reported. These results are interpreted in the light of the different contamination mechanisms involved. A new laundering technique is suggested, consisting in a single treatment in a regenerating column using appropriate acid solutions, in which the chemical elimination of radioactivity depends on an ion-exchange process. (Occup. Safety and Health Abstr.)

8554 PREVENTION OF HAZARDS DUE TO POLONIUM. de Petra, G.; Bernardini, M. Ann. Med. Navale, 70: 635-50 (Sept.-Oct. 1965).

The physico-chemical properties and metabolism of Po are reviewed. It is pointed out that Po spreads very rapidly throughout the working environment owing to its volatile nature. Safety measures recommended for the protection of persons exposed to radiation from Po and recent developments in the field of chemical and biological protection from ionizing radiation are discussed. The

Italian statutory provisions concerning the use of radioactive substances are included. The need for continuing medical research aimed at strengthening the protection of workers against these hazards is discussed. (Occup. Safety and Health Abstr.)

8555 THERMOLUMINESCENCE: A SIMPLE CLINICAL DOSIMETER. Burch, W. M. (Cancer Inst., Melbourne). Australas Radiol., 11: 280-5(Aug. 1967).

The minimum specifications applicable to an ideal dosimetry system are outlined briefly, and an intercomparison of present dosimetry systems is tabulated. The phenomenon of thermoluminescence and its application to dosimetry are sketched prior to some discussion of various thermoluminescence materials and observational techniques. Lithium fluoride, the phosphor most applicable to clinical dosimetry, is discussed fully. It is shown that a system based on LiF will exhibit little dependence on energy, and monitor doses in the range 10^{-2} to 10^{5} rad with an overall precision better than 5%. Present research and development of the dosimetry method is outlined. (auth)

8556 WHOLE-BODY COUNTING OF ^{90}Sr IN MAN IN THE PRESENCE OF OTHER RADIOACTIVE NUCLIDES (^{40}K, ^{137}Cs, ^{226}Ra). Karniewicz, Wieslawa (Inst. of Occupational Medicine, Lodz, Poland). Contract RB-126. Nukleonika, 12: 563-75 (Aug. 1967.).

Calibration of a whole body gamma-spectrometer for determination of ^{90}Sr body burden by means of bremsstrahlung counting is described in detail. Two independent methods were applied: using ^{90}Sr + ^{90}Y point sources in various absorbers and phantoms, and injection of pure ^{90}Y into living human beings. In the first method due corrections were introduced to account for geometrical factors and for differences in Z_{eff} between the calibration sources and human bone. In the second procedure a specific count-rate (calibration factor) was calculated from measured bremsstrahlung counts in three adults in whom complete balance of injected ^{90}Y was attained; an additional correction for bremsstrahlung of pure ^{90}Sr was introduced from experimental data. Both methods yielded calibration factors for whole body counting of ^{90}Sr in the standard chair that agreed to within 20 per cent. A synthesis of human gamma spectra in the energy range used for bremsstrahlung counting from measurement in photopeak region of ^{40}K, ^{137}Cs and ^{214}Bi (RaC) is described. The minimum detectable amount of ^{90}Sr in presence of 30 n Ci of ^{137}Cs amounts of 0.1 μCi; in presence of radium this value corresponds roughly to $^{1}/_{10}$ of the activity of ^{226}Ra. (auth)

8557 CONTROLLING AND EVALUATING PLUTONIUM DEPOSITION IN HUMANS. Wilson, R. H. (ITT Federal Support Services, Richland, Wash.). pp 831-44 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Currently accepted practices for controlling plutonium exposure in humans is reviewed with emphasis placed on the practical application of control and evaluation methods. Accidental exposure and modes of intake are discussed, along with measurement techniques, including air sampling, personnel decontamination techniques, biological sampling, evaluation of internally deposited plutonium, and special therapeutic treatment. (P.C.H.)

8558 WHOLE BODY COUNTING OF INHALED PLUTONIUM IN DOGS. Swinth, K. L.; Griffin, B. I.; Park, J. F. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Health Phys., 13: 1223-31(Nov. 1967).

Thin NaI(Tl) scintillation counters were used for the assessment of body burdens in dogs exposed to ^{239}Pu aerosol. Experiments were made with both a dog phantom and live dogs. Although the count rate was affected by changes in dog size and isotopic composition of the plutonium, the limiting factor in the accurate assessment of body burdens was the distribution of the plutonium within the dog. Despite these problems, the body burdens of dogs were determined with an accuracy of ±10% at 0.1 μCi levels. The average sensitivity obtained when counting the 17 keV X-rays emitted was 2.28 ± 0.16 counts/min/nCi, and was 13.3 ± 1.1 counts/min/nCi when counting both the X-rays and 60 keV ^{241}Am gamma rays. These sensitivities are based on body burdens determined by post-mortem alpha-counting analysis of the tissues of eight dogs that had previously been counted in the plutonium counter. In this study thirty exposed dogs were counted and body burdens ranging from 0.136 μCi to 3.12 μCi were observed. (auth) (UK)

8559 ^{90}Sr IN THE BONES OF BIG GAME IN THE WESTERN UNITED STATES. Fountain, Edmund L. (Defense Atomic Support Agency, Washington, D. C.); Seal, Morgan S. Health Phys., 13: 1205-9(Nov. 1967).

Bone samples from big game killed during hunting seasons were obtained for determination of the ^{90}Sr present. The observed content of ^{90}Sr rose slightly in 1959, decreased in 1961, and rose again in late 1964 and early 1965. Annual rainfall and the dietary habits of the observed animals appeared to influence the ^{90}Sr content more than the proximity to the Nevada Test Site. (auth) (UK)

Medicine

Refer also to abstracts 8433, 8447, 8470, 8484, 8493, 8495, 8537, 8546, 8592, 8595, 8599, 8631, 8635, 8641, 8644, and 8664.

8560 (ABCC-TR-16-63) CARCINOGENESIS IN HIROSHIMA AND NAGASAKI. OBSERVATIONS FROM ABCC–JNIH PATHOLOGY AND STATISTICAL STUDIES. Zeldis, Louis J.; Jablon, Seymour; Ishida, Morihiro (Atomic Bomb Casualty Commission, Hiroshima (Japan)). 1963. 15p. (In English and Japanese). Dep. CFSTI.

Estimates of the numbers of civilians exposed to the bombs, of the early mortality, and of the number of survivors in November, 1945 in Hiroshima and Nagasaki are tabulated. Major differences between the cities were noted with respect to numbers of survivors in the proximal zones. In Hiroshima, about 40% of the total population located within 5000 m were within a 2000 m perimeter; in Nagasaki, about 16% of those within 5000 m were in a corresponding 2000 m zone. Estimates of average radiation doses at various distances from the hypocenter in each city are presented. The gradient of radiation dose in each city is correlated with complex patterns of occupation, residence, economic status, and other factors, which may possibly affect the incidence of cancer. The life span study gives data on mortality in a known, fixed population group. Results of the study are tabulated by city and distance from hypocenter. Death rates per 1000 attributed to malignancy other than leukemia are tabulated by sex, age, and distance from the hypocenter for the period 1950 to 1959. A study of thyroid lesions in Hiroshima diagnosed at autopsy or by surgical pathology procedures revealed a high incidence of adenoma, carcinoma, and sclerosis. Data suggest that a carcinogenic effect is apparent under the conditions of radiation exposure that occurred in Hiroshima. The evidence does not yet demonstrate such an effect in Nagasaki. (H.L.W.)

8561 (COO–1223-10) HYPOXIA AND PARA-AMINOPROPIOPHENONE AS RADIOPROTECTIVE AGENTS. Progress Report, June 1, 1966–July 31, 1967. Bonner, John F. Jr. (Indiana Univ., Indianapolis. Dept. of Biochemistry). Aug. 1, 1967. Contract AT(11-1)-1223. 16p. Dep. CFSTI.

Radioprotective effects of carbon dioxide were demonstrated by irradiating mice in air, hyperbaric oxygen, or a hyperbaric mixture of oxygen and carbon dioxide. Effects of AET, MEA, and PAPP on survival of mice exposed to hyperbaric oxygen were studied; little or no effect was observed. Radioprotective effects of succinic and maleic hydrazides were demonstrated in mice. Oxygen and adenosine pyrophosphate were shown to be necessary for methemoglobin formation by mouse kidney slices in a PAPP solution. (H.L.W.)

8562 (NP–16875) CONTRIBUTION A L'ETUDE DU POUVOIR RADIOPROTECTEUR IN VITRO DE SIX COMPOSES HETEROCYCLIQUES AZOTES. (Contribution to Study of the Radioprotective Power In Vitro of Six Heterocyclic Nitrogen Compounds). Scarlot, Robert (Grenoble Univ. (France)). 1965. 73p. (In French). Dep.

Thesis.

The radioprotective power in vitro of six heterocyclic N compounds was studied with respect to the solution of hemin exposed to degradation by ionizing radiation. The destruction was followed by a spectrophotometric method. The compounds studied were imidazole, imidazole-4-carboxylic acid, 4-hydroxy-imidazole, pyrazole, triazole, and piperazine. After irradiation with a soft x ray dose of 45 × 10^{4} R, a solution of hemin contains only 25% of the initial quantity of these bodies. If irradiation occurs in the presence of one of the compounds studied, the results showed that only piperazine remains completely inactive. All the other compounds are more or less radioprotectors since after irradiation approximately 50% of the hemin of the original solution remains. Pyrazole and imidazole-4-carboxylic acid seemed slightly more active as radioprotective substances. No relation could be established between the protection obtained in vivo and in vitro. Only imidazole is a radioprotector in vivo, whereas in vitro it is less active than pyrazole or imidazole-4-carboxylic acid. These two compounds were inefficient in vivo in mice. (tr-auth)

8563 (JPRS–42929) SHORT MANUAL ON TOXICOLOGY. Stepanskiy, G. A.; (and others). Translation of Kratkoe Rukovodstvo po Toksikologii, Meditsina Publishing House, Moscow, 1966. 375p. (TT–67-33555). CFSTI.

Separate abstracts were prepared for three chapters. The remaining thirteen chapters are on various aspects of toxicology and decontamination. Methods of diagnosis, pathology, and prevention are emphasized. (H.L.W.)

For abstracts of individual chapters see: 8528–8530.

8564 INTRALYMPHATIC RADIOISOTOPE THERAPY WITH ^{32}P-LECITHIN-ETHIODOL. Yamamoto, Yasuhisa; Yamamoto, Saburo; Tachibana, Akihisa; Yoshikawa, Satoshi (Okayama Univ., Japan). Radioisotopes (Tokyo), 16: 449-53(Sept. 1967). (In Japanese).

Phosphorus-32-labeled lecithin was biosynthesized in a rabbit, and purified by a cadmium-precipitation method. The lecithin was dissolved with ethiodol, and administered via the lymphatic canal to cancer patients. Uptake occurred in the lymphnodes and ^{32}P penetrated into the metastatic part of the cancer; this was readily recognized on the marco- and micro-autoradiogram. (auth)

8565 PARTICULAR CARRIAGE OF RADIORESISTANCE. Svet-Moldavskii, G. J.; Pavlotskii, A. I. (Inst. of Experimental and Clinical Oncology, Moscow). Lancet, 2: 779-80(Oct. 7, 1967).

Attempts were made to deliver a radioprotective agent specifically to certain organs where it might exert radioresistance without causing generalized toxicity reactions. The toxicity and protective effect of cystamine in aqueous solution and adsorbed on India ink were studied in female mice (BALB/c strain). Chromatography on filter paper showed that cystamine adsorption was complete at pH 7.0, with a cystamine/India ink ratio of 1/6. Cystamine adsorbed on powdered charcoal, in 1/6 ratio, was therefore used for oral administration. Twice as much cystamine adsorbed on India ink as cystamine in aqueous solution could be injected into mice intravenously without toxic manifestations. Aqueous solution of cystamine at a dose of 150 mg/Kg caused immediate convulsions and death of mice. Therefore, in irradiation experiments this dose of unadsorbed cystamine in aqueous solution had to be injected intraperitoneally. In other experiments the protective effect of 150 mg/Kg of cystamine in aqueous solution or when adsorbed, given 15 to 20 min before x irradiation of the mice with 800 R, was compared. A protective effect of India-ink-adsorbed cystamine was demonstrated. A comparison was also made of the effect of the same doses of unadsorbed and adsorbed cystamine given intravenously (50 mg/Kg) and per os (100 mg/Kg). Mice were irradiated with 560 R two hr after administration of the protective substance. By the 10th day all mice receiving adsorbed cystamine were alive without any abnormal signs. Mice receiving an aqueous solution of cystamine had loose stools, sickened, and died, beginning at seven days, with symptoms of radiation disease; only two of the 10 mice in this group survived for 10 days. (BBB)

8566 EFFECTS OF VINBLASTINE AND VINCRISTINE ON SURVIVAL AND HEMOPOIESIS IN IRRADIATED MICE. Smith, Willie W.; Wilson, Shirley M. (National Cancer Inst., Bethesda, Md.). J. Nat. Cancer Inst., 39: 1055-66(Nov. 1967).

Hemopoietic recovery is described in mice irradiated two days after an injection of vinblastine or vincristine, stathmokinetic agents whose destructive effects on bone marrow cellularity were most severe at that time. Recovery, that involved granulocyte, lymphocyte, and hemoglobin concentrations in the blood and marrow cellularity, occurred much earlier in the treated than in the untreated mice. The number of animals surviving longer than 28 days increased, though in some instances deaths were more numerous 3.5 to 4.5 days after irradiation. A working hypothesis consistent with the observations is proposed. (auth)

8567 SURVIVAL OF LETHALLY X-IRRADIATED RATS AFTER TREATMENT WITH ISOGENIC MARROW LYMPHOCYTES. Morrison, J. H.; Toepfer, J. R. (Kent State Univ., Ohio). Amer. J. Physiol., 213: 923-7(Oct. 1967).

Cell populations (layer 2 cells) containing a high percentage of lymphocytes were separated from rat bone marrow. The capacity of such cells to promote 30-day survival of lethally x-irradiated (700 R) rats was investigated. The number of 30-day survivors increased in proportion to the number of layer 2 cells injected. As few as 10^6 layer two cells afforded protection against mortality in 61% of the recipients. Doses of 6×10^6 layer two cells gave optimal protection. About five times as many isogenic whole bone marrow cells were required to confer a level of protection comparable to that afforded by the layer two cells. It appears that marrow lymphocytes are the cells in the layer two inoculum responsible for preventing mortality and promoting the hemopoietic recovery of lethally irradiated rats. (auth)

8568 ACHIEVEMENTS OF THE SOVIET X-RAY AND RADIOLOGICAL SCIENCE IN THE FIELD OF TUMOR DIAGNOSIS AND THERAPY. Zedgenidze, G. A.; Elashov, Yu. G. Vop. Onkol., 13: No. 4, 3-17(1967). (In Russian).

Development of radiology in Russia was strongly influenced by the socialist revolution. During the first 20 years after the discovery of x radiation, no true scientific and therapeutic work was undertaken in Czarist Russia. The first radiological cancer research institute was established in 1918 in Petrograd. The Roentgen diagnosis of malignant tumors by means of angiography was subsequently widely practiced in the Soviet Union. Among the diagnostic methods, the artificial pneumoperitoneum received special attention for the detection of liver tumors. Prophylactic fluorography also received special attention for detecting lung cancer cases. Use of radioactive isotopes is widespread; at present ^{32}P is employed for scanning studies. The therapeutic application of various forms of radiation is practiced in several specialized centers. In addition to a ^{60}Co source, several high-energy, light radioactive sources are in general use in cancer therapy research. The role of several scientists and physicians who played an important role in the history of tumor diagnostics and therapy, is described in detail. (Review article). (TTT)

8569 RADIOISOTOPE SKELETAL SURVEY. DeNardo, Gerald L. (Veterans Administration Hospital, Palo Alto, Calif.); Horner, Richard W.; Leach, Paul J.; Bowes, Donald J. J. Amer. Med. Ass., 200: 111-13(Apr. 1967).

A rapid, simple radioisotope method for the detection of localized bone disease was developed using a whole-body profile scanner and radiostrontium (^{85}Sr). This radioisotope offers the possibility of early detection of neoplastic bone disease because of accelerated mineral turnover or new bone formation. Accelerated new bone formation occurs in most patients with neoplastic bone disease. Strontium, like Ca, is deposited in bone and has suitable physical characteristics for studies in vivo. A survey of the skeleton for abnormal sites of ^{85}Sr localization can be completed in 10 to 15 min. In studies of several hundred patients with ^{85}Sr to detect bone disease, photoscans and profile scans were done 24 to 72 hr after intravenous administration of 25 to 100 μCi of ^{85}Sr as strontium nitrate. The radiation exposure to bone from 25 to 100 μCi ^{85}Sr is comparable to that from a roentgenographic skeletal survey and is determined to be within the acceptable range for single or repeated studies in patients with known neoplasm. In patients with malignant neoplasm the method proved to be more sensitive than photoscanning techniques and the roentgenographic skeletal survey. No profile scan was normal in the presence of bone involvement, and no false-positive results occurred. (BBB)

8570 COMBINATION 5-FLUOROURACIL AND X-RADIATION THERAPY FOR NONRESECTABLE BRONCHOGENIC CARCINOMA. Killen, Duncan A.; Zukoski, Charles F.; Gobbel, Walter G. Jr. (Veterans Administration Hospital, Nashville, Tenn.). J. Thorac. Cardiovasc. Surg., 54: 299-303(Aug. 1967).

Combined effects of 5-fluorouracil (5-FU) and x rays were studied in 25 patients. The regimen of 5-FU and x-radiation therapy consisted of a 10-day course (5 doses) of intravenous 5-FU and a 3- to 4-week course of conventional high-voltage x radiation (total tumor dose between 3500 and 4000 R) therapy given concomitantly. Comparison of the course of these patients with that of 258 similar patients in whom no specific treatment was given, and with that of 189 similar patients in whom x radiation alone was administered, revealed that combination 5-FU and x radiation therapy offers no advantage over x radiation therapy alone in the management of patients with nonresectable bronchogenic carcinoma. (BBB)

8571 THE FAT CONTENT OF LEG MUSCLES AND ITS INFLUENCE ON THE ^{133}Xe CLEARANCE METHOD OF BLOOD-FLOW MEASUREMENT. Lindbjerg, I. F.; Andersen, A. M.; Munck, O.; Joergensen, M. (Glostrup Hospital, Copenhagen). Scand. J. Clin. Lab. Invest., 18: 525-34(1966).

Since the inert gas xenon, which is widely employed for organ blood-flow measurement as ^{133}Xe, is highly soluble in lipids, its removal rate from an organ is largely influenced by the fat content of the tissue. A method employing ^{133}Xe was developed to examine the magnitude and variations of fat content in human leg muscles. This was of interest in attempts at quantitative measurements of muscle blood-flow by means of the ^{133}Xe clearance technique. It was shown that not only the absolute muscular fat content, but also its mode of distribution, determines the influence of the fat on blood-flow measurement with ^{133}Xe. If muscle tissue and fat are homogeneously mixed, an increase of the muscular fat content of 1% of the muscle weight may involve an underestimation of up to 25% of the muscle blood-flow as measured with the ^{133}Xe method, when a constant tissue-blood partition coefficient is applied without regard to the variations in muscle composition. If muscle tissue and fat are two separate parallel compartments, the error is only in the order of 1%/per cent of muscular fat. (BBB)

8572 CHEMOTHERAPY FOR ADVANCED OVARIAN CANCER. Rutledge, Felix; Burns, Beaury C. (M. D. Anderson Hospital, Houston, Tex.). Amer. J. Obstet. Gynecol., 96: 761-72(Nov. 15, 1966).

Whether x-ray treatment can be potentiated by preirradiation drug therapy with L-phenylalanine mustard (L-Sarcolysin, melphalan, Alkeran, PAM) was investigated in 288 patients with advanced inoperable ovarian cancer. Patients who initially had received high-dose irradiation generally tolerated the drug as well as those who received the drug only, thus demonstrating that PAM may be given safely after irradiation and may induce a response in a patient who had not responded to irradiation. However, irradiation following the drug seemed to be the most favorable sequence. Only rarely did the prior effect of the drug on the bone marrow force discontinuance of x-ray therapy. Many patients who initially could not tolerate irradiation responded so well to the drug with tumor mass reduction and control of ascitic fluid that they were then able to undergo intensive irradiation. The drug is useful in some patients in whom irradiation would be ineffective. Advanced cancer patients may still be treated with chemotherapy when the disease is too extensive for irradiation. If, for example, gross cancer growth is local but massive, or if ascites is present, irradiation is ineffective. If the tumor is small but widely dispersed, not all diseased areas can be effectively irradiated because the total area of the body that can be safely irradiated is limited. (BBB)

8573 MANAGEMENT OF PATIENTS WITH MALIGNANT LYMPHOMA. **Stein, Justin J. (Univ. of California, Los Angeles). Calif. Med., 104: 443-8(June 1966).**

Use of various types of radiation, the treatment preferred for malignant lymphoma, is reviewed. Attention is given to radiosensitivity of different kinds of malignant cells, advantages of megavoltage therapy, hazards to the fetus in pregnant patients, and estimated dose to the fetus. (TSS)

8574 THE GROWTH AND DEVELOPMENT OF CHILDREN EXPOSED IN UTERO TO THE ATOMIC BOMBS IN HIROSHIMA AND NAGASAKI. **Wood, James W.; Keehn, Robert J.; Kawamoto, Sadahisa; Johnson, Kenneth G. (Atomic Bomb Casualty Commission, Hiroshima). Amer. J. Public Health, 57: 1374-80 (Aug. 1967).**

Both exposed and control subjects who were in utero at the time of the atomic bombing in Hiroshima and Nagasaki were studied to evaluate growth attainment at the 17-yr level. The sample of 1613 Hiroshima and Nagasaki children was composed of 3 groups, based on the distance of the mothers from the hypocenter: 0- to 1999-m group, 3000- to 4999-m group, and not-in-city group. Except for Nagasaki females, mean head circumferences were smaller for those within 2000 m, as compared to the more distal groups. Mean standing height and weight were less for Hiroshima males and females and Nagasaki males who were within 2000 m as compared to the more distal groups. For each sex in both cities the means were smallest for the subgroups within 1500 m. Mean chest circumferences were smaller for subjects within 2000 m as compared to distal subjects. For most of the measurements the subgroups within 1500 m tended to have the lower values throughout the entire range. However, there was considerable variation and the differences were not impressive except for head circumference, height, and weight. The results indicated that exposure of the human fetus to the irradiation of the atomic bombs caused limitation of head and body size. (BBB)

8575 ROLE OF ENDOGENIC SULFHYDRYL GROUPS IN THE RADIOPROTECTIVE EFFECT OF HYPOTHERMIA. **Konstantinova, M. M.; Sokolova, O. M. Radiobiologiya, 7: 444-5 (1967). (In Russian).**

This study investigated the level of sulfhydryl (SH) groups in tissues of cooled animals and a possible relationship between SH-group levels and radioresistance. Experiments were performed on male and female white mice weighing 18 to 22 g. Sulfhydryl-group levels were determined by an amperometric titration method in homogenates prepared from spleens of animals with different body temperatures: group I – 6°C, group II – 18°C, group III – 30°C, group IV – 37°C (control), group V – 37°C. Aminazine (chlorpromazine) was administered to the first three groups; in the fifth group animals were in an anoxic state (3 min after death) with a normal temperature of 37°C. The animals were gamma irradiated (^{60}Co) with a single 900 R dose. Radioresistance of animals was based on the survival rate for a 30 day period. Findings show that the SH-group level remains unchanged in the spleen of mice with a body temperature of 30°C. Thus, the increased SH group levels found at lower temperatures are not related to aminazine administration, but reflect the reaction of the body to hypothermia. It should be noted that the increased SH group level induced by hypothermia (6°C) is the same as that found in anoxic animals at 37°C. A comparison of data on SH-group levels, pO_2 of the spleen, and radioresistance in relation to lowered body temperature shows a definite correlation between all three indices. The results appear to confirm data indicating that radioresistance of an organism is dependent on the endogenic SH-group level. (ATD)

8576 RADIOISOTOPE DIAGNOSIS OF RADIATION INJURIES OF THE KIDNEYS. **Bagdasarov, M. B. (Burdenko Main Military Hospital, USSR). Med. Radiol., 12: No. 12, 46-51(Dec. 1967). (In Russian).**

During radium therapy, when the kidney is in the zone of irradiation one could expect the development of radiation nephritis, hypertension; in high-dose irradiation deep destructive changes of the renal parenchyma may occur. If only one kidney is in the zone of irradiation the clinical manifestations of radiation injuries of the kidney may be very scarce. By the method of radioisotope renography and scanning of the kidneys one could diagnose radiation-induced functional disturbances of the kidneys and differentiate the functioning areas of renal parenchyma from the nonfunctioning ones. Experimental investigations staged on rabbits demonstrate the value of radioisotope methods of studying the kidneys in chronic radiation sickness and acute radiation injury of the kidneys. (auth)

8577 CHROMOSOME ABNORMALITIES IN BONE MARROW CELLS AFTER IRRADIATION. **Osono, Noboru; Tomonaka, Masanobu (Hiroshima Univ.). Nagasaki Igakkai Zasshi, 40: 715-21(Aug. 1965). (In Japanese).**

Observations of anomalies in bone marrow chromosomes in atomic bomb survivors and animal experiments on the irradiation effects on bone marrow chromosomes are reported. In 10 controls 95.5% of cells had chromosomes numbers of 46 to 47. However, in 14 atomic bomb survivors, exposed at a distance of 1.5 Km from the explosion, 94.4% had a chromosome number of 46. A giant dicentric chromosome was observed in 1 case. The 46 chromosome number in survivors at 1.6 to 2.0 Km from the explosion was found in 99.2% of cells examined. There was only a slight variation in maturation of bone marrow granulocytes in the atomic bomb survivors exposed proximally. In the animal experiments described, female rats at 5 weeks of age were irradiated at dose rates of 50 rad/min with x rays, 50 rad/min with ^{60}Co γ rays, and 1.68 rad/min with neutrons. After ^{60}Co γ irradiation abnormalities in chromosomes of bone marrow cells were found after a dose of 12.5 rad and the breakage of chromosomes increased after 100 rad, with breakage rate of 0.002/rad. After 200 rad of neutrons, γ rays, and x rays chromatid breakage was highest at 3 hr after irradiation then decreased gradually and disappeared 3 days later. The chromosome disturbances induced by neutrons were most severe and a 3-fold higher chromatid breakage rate was seen as compared with γ or x rays. The incidence of hyperploid cells was highest at 6 hr after irradiation, then it gradually decreased and still showed a residual effect at 14 days after irradiation. (BBB)

8578 EPIDEMIOLOGICAL STUDY ON MALIGNANT LYMPHOMA AMONG A. BOMB SURVIVORS IN HIROSHIMA. **Shimizu, Kiyoshi (Hiroshima Univ.). Hiroshima J. Med. Sci., 15: 201-11(Sept. 1966).**

Epidemiological and statistical data are presented on the occurrence of 28 cases of malignant lymphoma in Hiroshima atomic bomb survivors, which included 16 cases of reticulosarcoma and 12 cases of lymphosarcoma, during the 1955 to 1965 period. The frequency of occurrence was higher in males than in females, and it showed a linear relation to dose. A high frequency of lymphoma was also seen in those who entered the city from the 6th to the 8th of August, after the bombing. About one fourth of the total cases of reticulosarcoma was seen in persons exposed within 1000 m from the hypocenter, and one third of the cases of lymphosarcoma in those who entered the city from the 6th to the 8th of August; there were comparatively more males than females in both instances. From 1960 a decrease in the occurrence of the disease was noted. The highest incidence was recorded in those who were 40 years of age. It is concluded that malignant lymphoma occurred earlier in those who were proximally exposed than in the more distally exposed. (BBB)

8579 SUMMARY OF RESEARCH ACTIVITIES AT HIROSHIMA AND NAGASAKI BRANCH LABORATORIES. **Maki, Hiroshi (Hiroshima Branch Lab.); Nagai, Isamu. Jap. J. Med. Sci. Biol., 20: 15-19(Feb. 1967).**

The life-span, adult-health, and pathology studies on atomic bombing survivors, being conducted jointly by the Branch Laboratories of the Japanese National Inst. of Health and the Atomic Bomb Control Commission, are reviewed. In the study to determine whether life expectancy of the exposed group is shortened in comparison with the nonexposed control group, it was found that cumulative mortality in those exposed at distances under 1400 m was high during the years 1950 to 1955. Mortality rates were high from tuberculosis, leukemia, and malignant tumors, the leukemia mortality rate in particular being high in all years from 1950 to 1964. No other disease was noted to develop as a result of exposure to radiation, but a tendency toward earlier onset of some diseases and subsequent death was noted. A life-span study of children born to atomic bomb survivors is also in progress. In the adult-health study, detailed clinical examination is conducted biennially on survivors. Post-mortem examinations and histopathological study of surgical specimens are also being conducted. In a genetic study of 72,000 newborn children in Hiroshima and Nagasaki during the period from 1947 to 1953 (about 10% of whose parents were proximally exposed survivors), no significant difference from the control group was seen in the incidence of abortion, stillbirth, or malformations. Nor were there significant differences from the control group in the weight at birth or at 9 months of age for the infants born to exposed parents. The same was true of mortality rates in the 9-month period after birth. A relatively smaller head circumference was found in those who were exposed in utero within 1400 m of the hypocenter during the first trimester of gestation. Other findings were suggestive of higher incidence of thyroid cancer in those who were exposed within 1400 m of the hypocenter, especially in females. (BBB)

8580 HISTOLOGICAL STUDIES ON MYELOMA NEPHROSIS IN BOMB SURVIVORS. **Kubo, Minoru; Takagi, Hiroyuki; Nishimori, Ichusei (Nagasaki Univ., Japan). Nagasaki Igakkai Zasshi, 40: 612-15(Aug. 1965). (In Japnaese).**

Histological observations on myeloma nephrosis were made in six cases in atomic bomb survivors and 22 in control subjects. In most cases in atomic bomb survivors, typical myeloma nephrosis was observed, which showed the usual renal tubular changes. The incidence of the disease in nonsurvivors was relatively low. The occurrence of complications was higher in atomic bomb survivors and those with complications all died within 2 years. There was no correlation between the occurrence of myeloma nephrosis and the total serum protein or dysproteinemia. However, Bence-Jones protein was present. There was no significant difference in serum protein and urinary protein levels between the patients who were atomic bomb survivors or nonsurvivors. The occurrence of myeloma nephrosis in atomic bomb survivors was observed mainly in 50- to 60-yr-old subjects, but its occurrence was distributed over the 30- to 80-yr age range in nonsurvivors. In 70% of the cases among atomic bomb survivors survival ranged from 1 to 2 yr, but most control cases died within 1 yr. There was no correlation between the occurrence of myeloma nephrosis and other diseases observed in the atomic bomb survivors, e.g., myeloid leukemia, lymphatic leukemia, and lymphatic system tumors. (BBB)

8581 HISTOLOGIC STUDY OF LYMPH NODES TREATED BY ^{60}Co RADIATION IN THE CANCER OF CERVIC UTERI. **Mabe, Kazuaki (Kumamoto Univ., Japan). J. Jap. Obstet. Gynecol. Soc. (Engl. Ed.), 13: 216-17(July 1966).**

Relations were studied between the dose of radiation and histopathologic changes in lymph nodes treated by ^{60}Co radiation at doses measured accurately. The 19 cases of cancer of the cervix (seven cases of III stage, 12 cases of IV stage) were treated by radiation preoperatively. In comparison with nontreated lymph nodes in both superficial and deep sites, the disappearance of lymph follicles and swelling of reticulum cells were noted. With increasing doses of radiation, the more regressive degeneration was seen in lymphatic tissues, such as the atrophy of lymphatic parenchymal cells and increase of connective tissue. In lymph nodes with metastatic carcinoma cells, the original histological structure of lymphatic tissue disappeared after a dose of 600 R. Lymph follicles were completely destroyed and a slight increase of connective tissue was seen. On the other hand, in the carcinoma cells, only a slight regressive change was noted. In some of the lymph nodes treated with doses of 1500 R, the lymphatic tissue was completely destroyed, and increase of connective tissue was marked. Some carcinoma cells showed atypical growth. The degenerative changes in carcinoma cell and the radiation dose were not correlated. The results showed that degenerative changes in the carcinoma cells in superficial lymph nodes are caused by 4500 R or higher doses. On the contrary, carcinoma cells in the deep lymph nodes were less affected than in superficial ones at the same dose. It was shown that lymph nodes have resistance to ^{60}Co radiation, as noted by the slight degenerative changes in the lymphatic tissue, in spite of massive irradiation. (BBB)

8582 METOCLOPRAMIDE IN THE TREATMENT OF DIGESTIVE DISORDERS DUE TO RADIATION SICKNESS AND ANTICANCER CHEMOTHERAPY. **Pagnon, P.; Treguer, J.; Chassard, J.-L. (Centre Leon-Berard, Lyon). Lyon Med., 213: 1627-34(May 30, 1967). (In French).**

A study was made of 50 patients who received metoclopramide along with x radiation treatment, anticancer chemotherapy, or a combination of both methods. Of these patients 45 showed nausea with or without vomiting, and the 5 others were previously treated at a preventive dose level. Individual doses of 10 mg (tablets or injections, depending on whether or not there was vomiting) of metoclopramide was given at an average dose of 20 to 40 mg per patient. The results revealed 43 successful treatments (86%), 6 partial successes (12%), and 1 complete failure (2%). It was concluded that metoclopramide was more beneficial than other drugs for radiation sickness and digestive disorders resulting from chemotherapy for cancer. The reasons given are its high tolerability and ease of administration, as well as its effectiveness. (BBB)

8583 ETHER ANESTHESIA IN RADIATION SICKNESS. **Havlin, Igor (Traumatological Research Inst., Brno). Voj. Zdravot. Listy, 35: 221-2(Oct. 1966). (In Czech).**

The dependence of ether anesthesia on the different degrees and stages of radiation sickness was studied experimentally in rats. There was no statistically significant change in the time for the commencement and end of anesthesia. But there was a statistically significant relationship between the mortality rate of the anesthetized animals and the degree and phase of radiation sickness. (JPRS)

8584 AN INDIRECT METHOD OF BONE BLOOD-FLOW MEASUREMENT BASED ON THE BONE CLEARANCE OF A CIRCULATING BONE-SEEKING RADIOISOTOPE. **Shim, Sun Shik; Copp, D. Harold; Patterson, Frank P. (Univ. of British Columbia, Vancouver). J. Bone Joint Surg., 49A: 693-702(June 1967).**

A new method that employs radiostrontium and that provides a simple, reliable, and indirect method for measuring bone blood-flow in animals is described. It is based on the clearance of a circulating bone-seeking radioisotope and on an adaptation of the Fick principle. Clearance of the radioisotope is determined in the initial five min following intravenous injection. The clearance is obtained by dividing the bone uptake by the average arterial concentration of the isotope during the time studied. A dose of bone-seeking radioisotope (^{85}Sr or ^{45}Ca), of about 5 to 10 μCi/kg of body weight, is injected into the jugular vein within one sec. It was found that bone removes 50 to 75% of radiocalcium or strontium from the blood passing through it in the first 5 to 10 min of the test period. Ignoring the isotope in the veins, the Fick Formula $F = Q/A - V$ becomes $F_c = Q/A$, where F is the bone blood flow as the isotope clearance, Q is the bone uptake, and A is the systemic arterial isotope concentration. By this formula bone blood-flow can be estimated. The time-concentration curve for ^{85}Sr disappearance from the systemic artery based on average data from 10 dogs is given. It was demonstrated that bone uptake of ^{85}Sr in the first 5 min following intravenous systemic injection was entirely dependent on bone blood-flow. The ^{85}Sr uptake by ischemic femoral heads was only 1.5% of that by normal femoral heads, when uptake was measured 5 min after intravenous injection. (BBB)

8585 RADIOSTRONTIUM ^{85}Sr IN THE DIAGNOSIS OF BONE AND JOINT TUBERCULOSIS. **Kettunen, Kauka; Rekonen, Ahti (Central Hospital, Kuopio, Finland). Duodecim, 82: 1090-9(1966). (In Finnish).**

A new radioisotope method was developed using external counting of radiostrontium to diagnose incipient and recurring tuberculosis of the bone. The isotope used was ^{85}Sr in a dose of 50 μCi injected intravenously one week before counting. Incipient local inflammation of the bone such as occurs in bone tuberculosis causes stimulation of Ca and Sr in the inflammatory region. It is possible by means of external counting of ^{85}Sr to localize and quantitate this stimulation. External counting can reveal incipient tuberculosis of the bone at a phase when the roentgenological finding is still negative or uncertain. The method appeared to be suitable also for the early diagnosis of recurrent bone tuberculosis. However, considerable difficulties were often met in use of ^{85}Sr in the diagnosis of recurrences. For instance, operative interventions such as spondylodesis in tuberculous spondylitis caused an elevated uptake in the operative area for several years. The changes induced by tuberculous arthritis also caused an elevated uptake of ^{85}Sr in the articular area. Preliminary studies suggested that the described method can be used in the differential diagnosis of bone tuberculosis and some noninflammatory spinal diseases such as juvenile osteochondrosis and congenital vertebral anomalies. Clinically, the method had several disadvantages, leading to false interpretations. (BBB)

8586 PHARMACOLOGICAL STUDIES ON CHEMICAL PROTECTORS AGAINST RADIATION. II. INFLUENCE OF X IRRADIATION ON BODY WEIGHT OF MOUSE. **Shinoda, Masato; Goto, Momoko (National Inst. of Radiological Sciences, Chiba, Japan). Yakugaku Zasshi, 87: 658-62(June 1967). (In Japanese).**

When experimental animals are irradiated, the marked change in the initial stage is the loss in body weight. In order to determine if this loss in weight could be used as an index for biological assay of chemical radiation protectors, sensitivity of mouse weight to irradiation was examined. The body weight of male ddY mice shows specific loss on x-ray irradiation, and the rate of body weight change two weeks after the irradiation is linear to the dose. This rate of body weight change is much more sensitive than changes in survival rate, and effect of irradiation can be observed with a low dose and in a short period. (NSA of Japan)

8587 ADENOID CYSTIC CARCINOMA OF THE PAROTID GLAND. Blank, C.; Eneroth, C. M.; Jacobsson, F.; Jacobsson, P. A. Acta Radiol., Ther., Phys., Biol., 6: 177-96(June 1967).

A histologic re-examination and re-classification of a series of 1678 parotid tumours revealed that 35, or 2.1 percent, were adenoid cystic carcinomas. All the cases were followed-up for at least 5 years and 19 of them for more than 20 years. It is evident that the long-term prognosis for this type of tumour is extremely poor, and attention is drawn to the grave significance of spontaneous facial paralysis. The pathology and treatment are discussed. All but one case had received radiotherapy. External irradiation, before and after operation, as well as intercavitary radium therapy at operation were used. External radiotherapy was generally given by short distance techniques, using either teleradium or Co-60 units with 6 to 7 cm distance between radiation source and skin. Intercavity irradiation for 2.5 to 4 hours generally administered by applying one to four 50 mg radium sources enclosed in a metal container of 10 mm diameter. Data are given on radiotherapy, pre-operative radiotherapy, intercavitary radium therapy, postoperative radiotherapy, and radiosensitivity. (auth)

8588 INHIBITION OF ULTRAVIOLET-INDUCED CHROMOSOME BREAKS BY CYSTEAMINE IN 5-BROMOURACIL-SUBSTITUTED MAMMALIAN CELLS. Trosko, J. E.; Brewen, J. G. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Radiat. Res., 32: 200-13(1967). (ORNL-P-2566).

It has been demonstrated that the presence of cysteamine during irradiation brings about the reduction of uv-induced chromosome breaks in BU-substituted mammalian cells. Cysteamine had no or considerably less effect on the uv-induced chromosome breaks in non-BU-substituted cells, nor did it enhance the resumption of uv-induced inhibition of DNA synthesis in BU-substituted cells. The results have been interpreted to indicate that BUdR sensitization of uv-induced chromosomal damage in mammalian cells is due to the nature of the BU photoproduct and not to BU photoproduct inhibition of a rejoining process. Also, uv-induced photoproducts in BU-substituted cells that cause chromosome breaks might not be those that cause uv inhibition of DNA synthesis. (auth)

8589 RADIOISOTOPE LOCALIZATION OF THE PLACENTA. Shapiro, B. J.; Shaul, D. (New Mount Sinai Hospital, Toronto). Can. Med. Ass. J., 97: 218-21(July 29, 1967).

The accuracy of isotope localization of the placenta was determined. A carrier labeled with suitable radionuclide such as ^{131}I-labeled human serum albumin was injected intravenously and 10 minutes allowed to elapse. Counts were then taken over 12 uterine ports and also over the heart pool. The counts over the uterus were expressed as percentages of the counts over the heart pool. A total of 75 patients were studied: 60 because of antepartum hemorrhage, 12 before amniocentesis and three for miscellaneous reasons. The overall accuracy of localization was 96%. There were one false positive, one false negative and one failure of localization. The accuracy of this method compares favorably with a 78% accuracy of radiographic localization. The radiation dosage to the fetus is much less than with standard radiological techniques. (auth) (Canada)

8590 A STUDY OF THE ACTION OF A YEAST EXTRACT ON THE REVERSIBLE MITOTIC LAG IN HUMAN CELL CULTURES (HELA-S_3) AFTER SUBLETHAL X-RAY TREATMENT. Gandini, E.; Antonelli, A.; Ricci, N. (Univ., Ferrara, Italy). Atti Ass. Genet. Ital., 12: 164-75(1967).

An extract from yeast (YAF) was found to be mitogenic in vitro for human peripheral leukocytes. Evidence was collected which indicates that the sensitive cells represent a unique population held up in the post-DNA synthetic period (G_2). YAF has been tested also in HeLa S_3 cell cultures irradiated with sub-lethal doses of x rays. After exposure to low doses of x rays, HeLa cultures show a reversible mitotic lag due to a temporary block in the G_2 period, and the duration of the block is dose-dependent. It was found that when YAF was added to sublethally irradiated HeLa cells (80 rads) before irradiation, no mitotic lag was observed. The following preliminary results were obtained: When a dose of YAF containing 10 μg of P is added to a culture initiated 36 hrs before with 1 × 10^5 cells, complete protection from the reversible lag is observed. YAF inhibits reversibly the mitotic index in unirradiated S_3 cell cultures. YAF's protective action decays in presence of growing cells. (auth)

8591 RADIOBIOLOGICAL STUDIES IN THE YOUNG CHICKEN. Montour, James Leonard. Ann Arbor, Mich., University of Michigan, 1966. 115p.
Thesis.

Early mortality in the young chick was found to fall into two distinct time periods following exposure to x-rays, thermal neutrons or fission neutrons. A log organ weight-linear dose response was found for lymphatic depression following exposure to x-rays, thermal neutrons or fission neutrons. Aminoethylisothiouronium (AET) was effective in protecting against both early death and lymphatic involution following exposure to these three types of ionizing radiations. The lymphatic involution following radiation exposure was determined by partial body exposure techniques to be the result of three different types of injury: scopal damage or direct killing of lymphatic lymphocytes by the ionizing radiation, chick-type abscopal damage, that is involution through indirect processes as the result of damage to tissues other than lymphatic tissues, in this case the same injury that at higher doses leads to early mortality, and mammalian-type abscopal damage or stress resultant from injury to the gastrointestinal tract. (Disser. Abstr.)

Radiation Effects on Animals

Refer also to abstracts 8434, 8437–8439, 8441, 8446, 8452, 8454, 8458, 8459, 8462–8464, 8468–8470, 8488, 8495, 8498, 8500, 8506, 8509, 8512, 8517, 8519, 8525, 8526, 8534, 8537, 8542, 8560, 8565, 8566, 8574, 8575, 8577–8582, 8586, 8587, 8591, and 9129.

8592 (AD-629311) USAF RADIATION LABORATORY QUARTERLY PROGRESS REPORT NO. 58. (Chicago Univ., Ill. USAF Radiation Lab.). Jan. 15, 1966. Contract AF 41(609)-1693. 35p. CFSTI $2.00 cy, $0.50 mn.

Further studies on the effects of various drugs on the adenosine triphosphatase activity of the hematopoietic tissues of rats exposed repeatedly to cobalt-60 γ radiation; studies on the effect of x-radiation on the hexobarbital metabolizing system of liver microsomes; and hypobaric oxygen exposure and acute x-radiation lethality in mice are presented. (CFSTI)

8593 (CONF-670305–, pp 51-62) FUNDAMENTAL ASPECTS OF THE DEPENDENCE OF BIOLOGICAL RADIATION DAMAGE IN HUMAN CELLS ON THE LINEAR ENERGY TRANSFER OF DIFFERENT RADIATIONS. Barendsen, G. W. (Gezondheidsorganisatie TNO, Rijswijk (Netherlands). Radiobiologisch Instituut).

Fundamental aspects of the relation between RBE and LET of ionizing radiations for impairment of the proliferative capacity of cultured human cells; the relation between oxygen enhancement ratios (OER) and RBE for radiations with wide distribution of dose in LET; and the variations in RBE of ionizing radiations attributable to dose fractionation, dose rate, and environmental conditions (protective compounds, temperature) of cells are discussed. (B.H.S.)

8594 (CONF-670305–, pp 76-80) TISSUE, ORGAN, AND ORGANISM EFFECTS. Patt, Harvey M. (California Univ., San Francisco. Lab. of Radiobiology).

Whole-body x irradiation in the dose range from 10^2 rads to 10^5 rads results in the death of chickens and rabbits from several weeks to several seconds, respectively, following exposure. Survivors of massive doses demonstrate shortened life spans. The degree of radiosensitivity of an organism is a reflection of the essentiality of the system within which cell damage has occurred. The radiosensitivity of a cell type depends directly on the rate of proliferation of the cell and the number of future mitoses prior to maturity. The degree to which a system reflects irradiation damage depends on the time length of the developmental pathway between proliferation and functional maturity of the constituent cells. This time increases in chickens and rabbits with decrease in radiosensitivity from intestinal epithelium, to bone marrow, to testes. That the initial lesion resulting from x radiation is at the level of proliferation of stem cells is evidenced by the time lag between exposure and perturbation of turnover kinetics of the functional cells of the system. Organismic radiosensitivity seems to reflect differences in recovery rate rather than extent of initial injury among chickens and rabbits studied. Following acute whole-body exposure to x radiation, sensitivity to subsequent or prolonged exposure decreases. Adaptive response is reflected either by increased stem cell turnover or by increased recruitment. (E.R.B.)

8595 (CONF-670305–, pp 114-27) EFFECTS OF TOTAL- AND PARTIAL-BODY THERAPEUTIC IRRADIATION IN MAN. Saenger, Eugene L. (Cincinnati Univ., Ohio. Coll. of Medicine).

Carefully controlled clinical observations on man can continue to expand an understanding of acute radiation injury in addition to yielding information on the palliative effects of this form of treatment. Data are presented to expand an understanding of the interacting of radiations with biological matter, and to aid in solving the difficult problems of diagnosis, therapy, and prognosis of acutely and seriously injured man. Extensive data are given comparing and evaluating the effects of whole- and partial-body irradiation on man at various dose levels, fractionation times, and radiation sources. (E.R.B.)

8596 (CONF-670305–, pp 128-42) DATA FROM ANIMAL EXPERIMENTS. Fowler, J. F. (Hammersmith Hospital, London (England). Postgraduate Medical School).

Data are presented on the relation of LET to somatic effects of α particles, deuteron beams, neutron beams, and x rays on the skin of mice, pigs, and rats. The RBE of radiations for a given biological system is dependent upon factors and as distribution of LET, dose rate, cellular radiosensitivity, and the cellular kinetics involved. Results point to the efficacy of fast neutron beams in therapy. (E.R.B.)

8597 (CONF-670305–, pp 230-40) TWO HAZARD-EVALUATION CRITERIA: DOSE EQUIVALENT AND FRACTIONAL CELL LETHALITY. Curtis, Stanley B. (California Univ., Berkeley. Lawrence Radiation Lab.).

Two approaches to the problem of radiation hazard evaluation are discussed. The first is a direct approach using an LET spectrum and the appropriate quality factor (QF) for the calculation of a dose equivalent (DE) for the organ under consideration. The second more speculative approach, eliminates the need to deal with RBE's and QF's substituting for them for concept of cross section. The fractional cell lethality (FCL) approach is based on the calculation of an inactivation cross section defined as the probability of the inactivation of a cell incident particle cm^2. Limitations of the criteria are discussed. (E.R.B.)

8598 (CONF-670305–, pp 289-96) RADIATION EXPOSURE LIMITS AND THEIR BIOLOGICAL BASIS. Jones, Hardin B. (California Univ., Berkeley).

Historical development of theories of the relation between radiation dose and effect is presented. Evidence is presented for the fact that there appears to be no threshold dose for radiation damage and that a continuum in the proportionality-risk curve better represents the dose-effect relation. At what point man deems this risk to constitute a threat therefore becomes a function of social interaction. (E.R.B.)

8599 (CONF-670305–, pp 346-8) π^- MESONS, RADIOBIOLOGY, AND CANCER THERAPY. Richman, Chaim (Southwest Center for Advanced Studies, Dallas, Tex.).

The pion is unique among recently discovered radiations in the field of high-energy physics in that it has the properties that might improve cancer therapy. It is a lightly ionizing particle in flight, capable of penetrating tissue to phenomonal depth and delivering a dose in the region of stripping, a large fraction of which is of high LET. The radiobiology of pion beams is presently being established and results to date are encouraging with respect to RBE and LET. The use of pion beams in cancer therapy is promising owing to the very low dose compared to conventional therapeutic beams and to possibilities for dose fractionation. (E.B.R.)

8600 (CONF-670305–, pp 368-81) PION RADIOBIOLOGY. Feola, J. M.; Loughman, W. D.; Richman, S. P. (California Univ., Berkeley).

Radiobiological applications of negative pion beams are discussed. The unique properties of these beams make them particularly suitable for use in radiotherapy. The primary disadvantage at this point is production of a beam of sufficient intensity to constitute a therapeutic dose. Experiments are described in which mice carrying ascites tumors were irradiated with the initial (plateau) portion and the terminal (peak) portion of a pion beam; the cytological effects were determined. Results indicated that the pion beams in the peak regions had a higher RBE than those in the plateau region. The LET in the peak region indicated an effect independent of oxygen, a favorable factor in applications to radiotherapy. (E.R.B.)

8601 RADIATION LESION OF NUCLEAR STRUCTURES OF BONE MARROW CELLS IN MONKEYS. Kosichenko, L. P. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Byull. Eksp. Biol. Med., 63: No. 5, 101-4(May 1967). (In Russian).

Monkeys, irradiated with 100 R were studied for radiation lesions of bone marrow cells and mitotic activity. Two hours after irradiation 70.1% of cells had radiation lesions. Simultaneously there was a four-fold decrease of mitotic activity, as compared with the control group. After restoration of the mitotic activity (30 hours later) percentage of radiation lesions in chromosomes decreased. In subsequent cellular generations (15 days) after irradiation no noticeable changes in lesion frequency as compared with the preceding period of the study were found. Three months after irradiation the number of chromosome changes was three times higher than in the control group. It is suggested that there is elimination of cells with the more pronounced nuclear lesions in the first cellular generations and prolonged conservations of chromosomes with changes that are less unfavorable for the body. (auth)

8602 INCIDENCE AND PATHOGENESIS OF SKIN TUMOURS IN MICE IRRADIATED WITH SINGLE EXTERNAL DOSES OF LOW ENERGY BETA PARTICLES. Hulse, E. V. (Medical Research Council, Harwell, Eng.). Brit. J. Cancer, 21: 531-47(Sept. 1967).

Part-body external irradiation of CBA mice with doses of ^{204}Tl beta particles gave a high incidence of skin tumors but did not otherwise shorten life. Malignant dermal tumors were most numerous but malignant epidermal and benign dermal tumors also occurred. Benign epidermal tumors were not significantly increased. None of the tumors regressed. The latent period was much longer than that for radioinduced leukemia in the same strain and deaths from radioinduced skin tumors were most numerous at the end of the second and beginning of the third year after irradiation. Tumor incidence increased after doses that gave mild radiation changes in the skin. The tumors all arose in irradiated skin and there was no evidence that migrating nonirradiated cells played any part in their genesis. The process of tumor induction, that dominates the part of the dose response curve relating to lower doses, leads to a steep increase in tumor incidence until the progressive loss of the reproductive integrity of the affected tissues reduces tumor yield. The dose response curve is not inconsistent with the hypothesis that carcinogenesis depends on two successive cellular events. (auth)

8603 LACK OF RESPONSE BY GROWING-FINISHING PIGS TO GERMICIDAL ULTRAVIOLET RADIATION. Morrison, S. R.; Hintz, H. F.; Givens, R. L. (Univ. of California, Davis). J. Agr. Sci., 69: 131-2(Aug. 1967).

The effect of uv radiation on the weight gain of swine fed a diet sufficient in vitamin D was investigated. The tests were conducted over a period of two winters and one summer. Germicidal lamps (2537 Å) with outputs of 5.2w were placed 3 m above the center of each pen and operated continuously. It was concluded that uv irradiation did not affect the rate of weight gain or feed efficiency and that earlier reports of benefits of uv radiation to animals and birds were probably due entirely to vitamin D-deficient rations. (BBB) (TSS)

8604 CALCIUM AND THE CONTROL OF MITOSIS IN THE MAMMAL. Perris, A. D.; Whitfield, J. F. (National Research Council of Canada, Ottawa). Nature (London), 216: 1350-1 (Dec. 30, 1967).

It has been found that increase of the calcium concentration in the environment of various types of isolated mammalian and insect cells hastens their progress through mitosis and also counteracts transient mitotic inhibition following irradiation. Similar effects can be produced in the bone marrow and thymus of the whole animal by raising the blood calcium. Conversely, reducing the total calcium level in the blood by injection of EDTA or inorganic phosphate should reduce the mitotic activity in normal and irradiated marrow and thymus in vivo. The study described indicates, however, that these materials stimulated mitosis. Rats were injected intraperitoneally with colchicine either at the commencement of the experiment, or immediately after ^{60}Co γ-irradiation. The progress of cells through mitosis was thus arrested at metaphase, and their rate of entry into mitosis could be determined. EDTA, or disodium hydrogen phosphate, was then injected intraperitoneally. Marrow and thymus cell suspensions were prepared after various times and the percentage of cells in metaphase was determined. Blood calcium levels were also determined. Stimulation of mitosis by EDTA became evident as early as 2 hours after treatment. Thymus tissue was less active mitotically than marrow, but mitosis was stimulated by EDTA. Phosphate solution also accelerated mitosis, but was slightly less effective than EDTA. The unexpected stimulation of mitosis by EDTA and phosphate is attributed to abnormally elevated ionized calcium levels which follow the initial lowering of the level. Plasma calcium levels are controlled by two antagonistic hormones; parathyroid hormone causes a surge of ionized calcium, which restores total calcium levels to normal after a sudden depression, and calcitonin depresses abnormally high levels. Any changes in the balance of these hormones will probably be accompanied by changes in the mitotic activity of the lymphatic and hemopoietic tissues. (UK)

8605 EXPERIMENTAL INFECTION WITH CANDIDA ALBICANS IN MODIFIED HOSTS. Hurley, Rosalinde (Queen Charlotte's Maternity Hospital, London). J. Pathol. Bacteriol., 92: 57-67(July 1966).

The experimental disease resulting from intravenous injection of Candida albicans in healthy mice and rabbits, in mice modified by naturally occurring infections of Proteus morgani, in mice subjected to whole-body x irradiation, and in rabbits made diabetic by the administration of alloxan is described. Mice received 160, 220, 240, 330, or 495 rad and were then injected with C. albicans (125,000 to 500,000 organisms) three to five days after irradiation. All animals that were irradiated and that received an infecting dose of 500,000 organisms died within 48 hr; mortality rates in the other animals are given. Control animals that received only fungi showed the usual lesions of acute candidiosis. The distribution patterns of the mycotic lesions in the animals that received lethal doses of fungi within three days of the whole-body irradiation at 495 or 330 rad differed from those in the nonirradiated controls. In addition to the heart, brain, and kidney, the lungs and liver were affected. The lungs contained discrete, multiple, mycotic foci that were composed of yeasts, proliferating mycelia, and inflammatory cells (polymorphonuclear leucocytes and lymphocytes). Animals that received smaller doses of x radiation (240 and 160 rad) and doses of fungi that were sublethal for healthy animals died within a few days. At these radiation doses the pattern of distribution of the lesions was the same as in the nonirradiated controls. It was evident that modified hosts were more susceptible to fatal infections than unmodified hosts, that organs usually spared were affected, and that bizarre forms of the fungi appeared in the mycotic foci. (BBB) (TSS)

8606 CLINICAL OCULAR LASER COAGULATION. **Zweng, H. Christian (Stanford Univ., Palo Alto, Calif.). Int. Ophthalmol. Clin., 6: 319-34(Summer 1966).**

Effects of laser radiation on the human retina are described. The laser impact sites underwent the following changes. In about 30 min edema accumulated and obliterated the original structure of the lesions. The edema cleared fairly rapidly during the first three days; the sites then began to show pigment accumulation that was quite dense by seven to ten days. After several months, pigment migration occurred so that some granules could be seen about 0.5 mm from the edge of the original lesion. If retinal or vitreal bubbles were produced, they were absorbed in about 5 min. Grade 3 retinal hemorrhages cleared in four to seven days, while grade 4 hemorrhages took as long as 14 days to be absorbed. (BBB)

8607 MORTALITY AND INTERNAL HEATING IN RADIO-FREQUENCY-TREATED LARVAE OF TENEBRIO MOLITOR. **Kadoum, A. M.; Nelson, S. O.; Stetson, L. E. (Univ. of Nebraska, Lincoln). Ann. Entomol. Soc. Amer., 60: 885-9(Sept. 15, 1967).**

Mortality of larvae of the yellow mealworm T. molitor, exposed to 39 MHz rf fields in confining polystyrene holders increased with exposure time and voltage applied across the holder. Mortality continued to increase over a two-week period following exposure. Internal thoracic temperatures induced by the rf treatments increased almost linearly with length of exposure. Temperatures in the thorax and last abdominal segment were significantly higher than temperatures in the cervical region or in the first and fourth abdominal segments, probably because the appendages in this region caused development of higher electric field intensities. Measured thoracic temperatures approached levels that were normally lethal so internal heating was suggested as the cause of death. (BBB)

8608 METABOLISM IN THE YELLOW MEALWORM, TENEBRIO MOLITOR (COLEOPTERA: TENEBRIONIDAE), FOLLOWING EXPOSURE TO RADIOFREQUENCY ELECTRIC FIELDS. **Kadoum, Ahmed M. (Kansas State Univ., Manhattan); Ball, Harold J.; Stetson, LaVerne E. Ann. Entomol. Soc. Amer., 60: 1195-9(Nov. 15, 1967).**

The 92- to 100-day old larvae were exposed either to continuous rf fields at 39 MHz, using an electrode voltage of 3.5 KV for 5.5 sec, or to pulse-modular rf fields for 19 sec at a rate of 20 pulses/sec, using a pulse width of 5 msec at 39 MHz and 6.0 KV. Larvae briefly exposed to rf fields showed progressive loss of body weight during the ensuing week. Younger larvae lost proportionately more weight than older larvae. The rate of oxygen consumption in rf-treated larvae rose promptly after treatment and persisted at a high level through the fourth posttreatment day before declining to control levels. Surgically injured larvae exhibited oxygen uptake rates that paralleled those obtained from rf-treated larvae. (BBB)

8609 SUPPRESSION OF EXPERIMENTAL ALLERGIC ENCEPHALOMYELITIS IN MICE BY IRRADIATION OF THE TARGET ORGAN. **Scheinberg, L. C.; Lee, J. M.; Taylor, J. M. (Yeshiva Univ., New York. Rockefeller Univ., New York). Nature (London), 216: 924-5(Dec. 2, 1967).**

Studies are reported on the suppressive effect of localized irradiation of the brain in mice during induction of experimental allergic encephalomyelitis (EAE), as compared with the effects of total body irradiation. The mice were sensitized by intraperitoneal injection of Haemophilus pertussis vaccine, and after four days given an intradermal injection of mouse brain with adjuvant, this treatment being repeated 10 days after the first sensitization. The mice were irradiated at intervals, with varying doses administered to the total animal, head only, or body only. The brains were subjected to histological examination. Sensitized non-irradiated control animals all showed typical brain lesions. Results are tabulated for high (2000 R) irradiation doses, and also for low (500 R) doses. Brain lesions in irradiated animals were found to be predominantly mild, but the lethal effect of total body irradiation was very evident. At 500 R more mice survived, but there was a slightly higher incidence of positive brain lesions than when only the head was irradiated; at 2000 R there were fewer brain lesions but more animals died from radiation sickness. A possibility is that entrance of sensitized lymphocytes into the central nervous system is impaired by irradiating the head; these cells are destroyed, and the disease is suppressed. (UK)

8610 THE INFLUENCE OF X-RAYS ON THE DEVELOPMENT OF EMBRYOS OF TUBIFEX. **Dobrowolski, J. (Dept. of Experimental Zoology, Krakow). Folia Biol. (Warsaw), 15: 353-65(1967).**

Mosaic eggs of Tubifex tubifex were x-irradiated in cocoons containing approximately 60 individuals all at the same stage of development. Groups of 10 cocoons at each of eleven stages of development were subjected to x ray doses of 2310 R and 4620 R. Nonirradiated cocoons were kept at analogous conditions, for the period of time required for irradiation, for controls. Postirradiation changes were observed for each of the eleven stages of development and compared with the control development of nonirradiated eggs and embryos. These results are presented in tabular form. Effects of irradiation are discussed in terms of lethality, teratology, and delayed emergence from cocoon. The effects of x-rays on the developing eggs and embryos are compared with the effects of nitrogen mustard. (E.R.B.)

8611 TREATMENT OF POLYCYTHEMIA VERA. **Watkins, P. J. (General Hospital, Birmingham, Eng.); Fairley, G. Hamilton; Scott, Ronald Bodley. Brit. Med. J., 1: 664-6(June 10, 1967).**

Incidence of leukemia and other radioinduced side-effects of treatment of this disease with radiophosphorus was evaluated in a clinical study of 81 patients and by a review of the pertinent literature. Median survival time of 78 patients treated with ^{32}P was between ten and 11 years; 23 (50%) of the 46 deaths were due to vascular causes. There was one case of acute leukemia and one of acute erythemic myelosis (Di Guglielmo's disease) among this group. The incidence of acute leukemia in irradiated (^{32}P and/or radiotherapy) polycythemic patients varies widely, between 0 and 30% of deaths in different series (considering only the larger series), and in half is 15% or more. In the present series of 46 deaths there was one case of acute leukemia and one of acute erythemic myelosis. The absence of acute leukemia in irradiated series is exceptional, but was reported in 1959 (28 deaths) and in 1965 (43 deaths). Reports of acute leukemia occurring in nonirradiated series were infrequent, and much less common than in irradiated series. That ^{32}P induces acute leukemia was also suggested from other evidence. However, ^{32}P-treated patients may actually survive longer than any other group and the frequency of acute leukemia decreases with the time at risk after irradiation. Though the incidence of acute leukemia in the irradiated groups is increased, the survival of both groups is similar. Moreover, the use of ^{32}P is free from side-effects and allows patients to live absolutely normal lives; this is in marked contrast to the many unpleasant side-effects that occur during chemotherapy. It is concluded that ^{32}P in association with venesection is the best treatment for polycythemia vera. (BBB)

8612 CONTACT PHOTODERMATITIS DUE TO BITHIONOL AND RELATED COMPOUNDS. **O'Quinn, Silas E.; Kennedy, C. Barrett; Isbell, Kathryn H. (Louisiana State Univ., New Orleans). J. Amer. Med. Ass., 199: 89-92(Jan. 9, 1967).**

The effects of uv light (from a carbon-arc lamp) were studied in 59 patients with photodermatitis. The accumulating evidence indicates that in the process of biological photosensitization to fluorescent compounds, there is a generation of free radicals on light exposure and that these free radicals produce biological changes in the irradiated system. Furthermore, compounds selectively absorbing photon energies in the uv range may, by adhering to nucleoprotein molecules, expose a cell to a larger proportion of photon energy. These observations suggest that in some patients free radical formation and selective photon absorption might permanently alter groups or clones of cells so as to make them persistently photosensitive. (BBB) (TSS)

8613 INFLUENCE OF IONIZING RADIATIONS ON THE DEVELOPMENT OF THE NERVOUS SYSTEM. **Geets, W.**

(Cliniques Ste. Elisabeth, Brussels). Acta Genet. Med. Gemellol., 16: 275-309(July 1967). (In French).

Experimental and clinical evidence of anomalies caused by irradiation of the developing nervous system is reviewed. A chronological table showing the anatomical or functional deformities in relation to the embryonic age at which the radiation was given is presented. It appeared that in man the most hazardous period was between the beginning of the second and the end of the eighth week after conception. The fetal or neonatal nervous system of rodents and primates was still radiosensitive, especially at the cerebral cortex level and the consequences of irradiation at this time were manifested as neurophysiologic or psychosensorial deficits. Certain embryopathies and neurologic alterations were apparent in subsequent generations, following mutations induced in the parental cells. Genetic deformities of the nervous system also resulted from moderate-dose irradiation of the gonads. In addition to results of experimental research on the radiovulnerability of the embryonic and fetal nervous system of animals, certain clinical observations are presented. (TSS)

8614 INFLUENCE OF ULTRAVIOLET RADIATION ON THE POST-EMBRYONAL DEVELOPMENT OF THE OVARY OF A WHITE MOUSE. **Stoklosowa, Stanislawa (Jagellonian Univ., Krakow). Vestn. Cesk. Spolecnosti Zool., 29: 183-96 (May 1965).**

Female mice were exposed daily for 10- to 15-min periods to uv radiation in the wavelength ranges of 289 to 405 and 254 to 405 nm, for total doses of 23,000, 36,200, or 55,000 erg/sec-cm^2. Ovaries of irradiated mice showed accelerated development of both primordial and Graffian follicles. General proliferation of germinal elements and blood vessels was more advanced in irradiated mouse ovaries. The broader uv wavelength range, corresponding to that of sunlight, was more effective but produced more skin burns and mortality than the narrower range. The number of atretic follicles increased more rapidly in the irradiated mice, as a result of the accelerated maturation of follicles caused by uv irradiation. Pregnancy was inhibited by high-dose irradiation in the 254 to 405 nm range (55,000 erg/sec-cm^2, in 15-min daily exposures). Histochemical tests for RNA, DNA, and mucopolysaccharides in the irradiated ovaries did not reveal any noteworthy deviations from the normal pattern. (BBB)

8615 IRRADIATION AND ATHEROSCLEROSIS IN PIGEONS. **Nutr. Rev., 24: 178-9(June 1966).**

White Carneau pigeons, known to be extremely susceptible to development of aortic atherosclerotic lesions with or without additional cholesterol in the diet, were used to investigate the possible atherogenic effect of irradiation. Doses of x radiation were administered at rates of 10 or 20 R/min in 5- to 25-min sessions at two week intervals. The total cumulative exposure doses ranged from 250 to 6500 R. Under no conditions tested did irradiation appear to have an effect on the occurrence of aortic atherosclerotic lesions in White Carneau pigeons. However, histological examination of the hearts and coronary arteries of pigeons given a low level, 0.1%, of cholesterol and high radiation doses (5500 R), revealed significantly greater prevalence and severity of coronary atherosclerosis than in nonirradiated animals of the same age and on the same diet. There appeared to be some added effect of exposure to radiation and cholesterol feeding on the prevalence and severity of aortic atherosclerotic lesions in a resistant breed (Show Racer) of pigeons receiving high doses (1950 to 5500 R). In these birds the incidence of atherosclerosis was about 80% in control and nearly 100% in irradiated birds. Also, the cholesterol content of aortas of the Show Racers given 2000 R and fed a 1% cholesterol diet was higher than in nonirradiated controls. Biochemical studies of lipid metabolism in livers and aortas revealed no defect that could be correlated with irradiation. It was concluded that high radiation doses and cholesterol feeding for many months may increase the prevalence and severity of atherosclerosis but that it is probably of limited importance. (BBB)

8616 PITUITARY RADIOTHERAPY. Levene, Martin B. (Lemuel Shattuck Hospital, Jamaica Plain, Mass.). Radiol. Clin. N. Amer., 5: 333-48(Aug. 1967).

Radiation effects on the normal pituitary are described as well as side-effects and complications of radiotherapy. The normal adult pituitary gland was relatively radioresistant. Pituitary irradiation in young animals at modest doses produced suppression of anterior pituitary activity. Hypopituitary dwarfism developed in a patient treated for nasopharyngeal carcinoma at age 12 with two courses of therapy to the base of the skull with 4000-KV radiation, the first with a tissue dose of 4080 R and the second, three months later, with a tissue dose of 5205 R in 45 days. The hazards of damage to surrounding tissues made delivery of doses in excess of 10,000 R impracticable with externally administered x or γ rays. However, heavy particle therapy provided much higher doses with diminished hazards. With doses of less than 20,000 rad there was only infrequent histologic evidence of necrosis while with over 20,000 rad evidence of histological damage was observed. One patient who received 30,000 rad and survived 14 months was found to have a virtually empty sella turcica at necropsy. Studies of patients treated by interstitial techniques yielded somewhat higher figures for doses required for pituitary necrosis. (BBB)

8617 CANCER OF THE THYROID IN THE YOUNG INDIVIDUAL. McKenzie, A. D. (Vancouver General Hospital, Can.). Pacific Med. Surg., 75: 273-80(Sept.-Oct. 1967).

In a 14-yr period (1952 to 1965 inclusive) at the Vancouver General Hospital and British Columbia Cancer Institute a Thyroid Tumor Registry recorded 230 cases of cancer of the thyroid. Of these, 54 occurred in individuals less than 30 yr of age at the time of diagnosis. This group included 13 invasive adenomas, 38 differentiated carcinomas, and 3 other carcinomas (1 each of medullary, small cell undifferentiated, and sclerosing carcinoma). A common feature was a striking incidence of irradiation of the thyroid in infancy in this group. In 19 of the 38 cases such a history was obtained; 16 had been irradiated for thymic enlargement and three for infantile eczema. Several were born in the Vancouver General Hospital and a search of the birth record of a young thyroid carcinoma patient often revealed details of irradiation treatment. It was noted that an apparent carcinogenic effect may occur also with irradiation given in childhood or youth for a benign cervical condition. Also reported are three cases from the registry where irradiation treatment given for benign disease (2 cases of tuberculosis adenitis, 1 case of laryngeal papilloma) was followed 20 to 30 years later by both squamous cell carcinoma of the laryngopharynx and follicular carcinoma of the thyroid. It was concluded that irradiation for thyroid cancer of the young should be reserved for situations not amenable to surgery. (BBB)

8618 TREATMENT OF STAGE I AND STAGE II CARCINOMA OF THE CERVIX: RESULTS OF COMBINED IRRADIATION AND SURGICAL TREATMENT. Weed, John C. (Ochsner Clinic, New Orleans). Pacific Med. Surg., 75: 319-25(Sept.-Oct. 1967).

Radiation injuries occurring in a series of 121 patients treated by Ra and x rays are reported. Radium was applied by both intracavitary tandem and vaginal colpostats to deliver 6700 R to point A in the pelvis. Some patients also received external irradiation before application of Ra. In these patients external irradiation reduced local cellulitis and edema and enabled more effective application of Ra. Four weeks after use of Ra the patient was examined to evaluate the local effects of irradiation. During the initial period of intracavitary irradiation alone, extensive radiation necrosis occurred in the endocervical canal, and a more intense irradiation effect was noted. The interval between operation and Ra treatment ranged from four to more than 52 weeks. The principal complications of treatment according to stage of disease are listed. Some complications were due to irradiation alone. Factitial involvement of the rectum or rectosigmoid occurred in 14.5% of patients with Stage I disease. All subsided with symptomatic treatment. In patients with Stage II, 18% had factitial changes; three of these patients required surgical therapy; one had temporary colostomy; the second, resection of the terminal ileum; and the third, resection of the sigmoid colon with an end-to-end anastomosis. There were no persistent rectal ulcers or rectovaginal fistulas. Some patients had persistent painful cystitis that did not respond satisfactorily to the usual treatment, but all recovered without development of fistulas. Ureteritis probably occurred more often than recorded. In two patients ureteral obstruction developed. Urinary fistulas developed in five patients (4.1%), including two vesicovaginal fistulas, one of which subsided with an indwelling catheter and cortisone therapy. Ureterovaginal fistulas developed in only 2.5% of cases, only requiring nephrectomy. Fracture of the hip occurred in two women, two and six years after irradiation. (BBB)

8619 PULSED RUBY LASER LESIONS. **Flocks, Milton; Peabody, Robert (Stanford Univ., Calif.). Int. Ophthalmol. Clin., 6: 275-83(Summer 1966).**

Macroscopic and microscopic changes produced by laser irradiation of the eyes of rabbits, monkeys, and humans are described. Depending upon the energy levels utilized, the lesions varied in gross appearance from barely visible white patches of edema to lesions that contained massive vapor bubbles, hemorrhages, and tears. Microscopic sections showed dislocation of the pigment in the pigment epithelium and disappearance of the cells of the pigment layer. Firm adhesions between pigment epithelium, neuroepithelium, and superficial choroid were evident. The choroid also became disarranged with development of fibrous tissue and a mild infiltration of chronic inflammatory cells. In marked contrast to what occurred in animals with moderate energy input levels from 0.025 to 0.080 J, the inner layers of the retina in man were not altered microscopically and there were no demonstrable changes in the overlying vitreous, nerve fiber layer, ganglion cell layer, or inner nuclear layer. The choroid showed dense focal collections of lymphocytes at the lesion site. There was irregular clumping of the pigment epithelium, flattening and coalescence of the rods and cones, and irregular separation of the outer nuclear layer. The number of cells in the outer nuclear layer was decreased. (BBB)

8620 FACTORS DETERMINING OCULAR LASER LESIONS. Rose, H. W. (Stanford Univ., Palo Alto, Calif.). Int. Ophthalmol. Clin., 6: 253-61(Summer 1966).

The primary laser irradiation effects in the eye were not seen in the highly transparent neural or sensory cells of the retina, but in the retinal pigment epithelium, choroid pigment, and pigmented tumors. Focusing of the beam increased the local irradiance, but, except in extreme cases of defocusing or depigmentation, the depth level of highest energy absorption and the relative absorption in the axial direction were determined mostly by the pigmented layers of the retina and choroid. The pigments, largely melanins, were similar in both tissues. Transmission data for pigment epithelium and choroid of a darkly pigmented eye were given. Compared to radiation at 694.3 nm from a ruby laser, the wavelength of 1060 for the neodymium laser was transmitted less in the ocular media and absorbed less in the pigment epithelium and choroid. The spectral range around 450 nm was transmitted in the ocular media about as well as 1060 nm radiation but it was highly absorbed in the pigment epithelium and the choroid. The absorbed laser energy caused local heating, denaturation of protein and nucleotides, evaporation, excitation of molecules and atoms, chemical decomposition, and ionization. Except for chemically bound energy, nearly all absorbed energy resulted ultimately in heat. Exploding water vapor and suddenly formed gases could cause considerable mechanical destruction. Gas bubbles were sometimes seen, and were facilitated by the strong focusing of the laser beam and the consequently higher temperature peak reached in a small volume. After the absorption phase, heat was conducted away and, to a lesser degree, radiated away from the irradiated volume. Heat convection by blood flow could be a factor with long light pulses, e.g., eclipse burns, but was of small importance in lesions from pulsed lasers. (BBB)

8621 OCULAR HAZARDS OF LASER RADIATION. Zaret, Milton M. (New York Univ. Medical Center, N. Y.). Int. Ophthalmol. Clin., 6: 285-91(Summer 1966).

Effects of laser radiation on the eye are reviewed, with emphasis on the hazards involved, some of which may be unknown at present. At higher laser energies a spreading thermal wave may produce an enlarged lesion of edema and coagulation. This type of reaction can result in a central zone displaying tissue carbonization, a small retinal hole, a localized implosion of retina, vapor bubbles, and hemorrhage. In determining the threshold dose, it is important to consider that the required intensity of irradiation varies directly with the degree of pigmentation of the pigment epithelium of the retina. Although the ruby laser wavelength is in the visible portion of the electromagnetic spectrum, laser emission is an unusual form of radiation, and in some respects, it is better, compared to rf than to light energy. Late-appearing, harmful effects, such as cataract formation, may not begin to become apparent until after latent periods of many years. About 1% of the incident energy of each laser pulse is reflected at the cornea-to-air interface. Although assumed to be innocuous, nothing is really known about the potential injury that this may represent, not only to the epithelial cells but also to the nerve endings. The iris absorbs laser radiation efficiently and iridial injury can be produced readily. Subtle effects of iris injury, however, may not be apparent and the underlying mechanisms have not yet been seriously considered. The possibilities of late secondary glaucoma or cataract must also be considered. (BBB)

8622 BLADDER CARCINOMA: COMBINED RADIOTHERAPY AND SURGICAL TREATMENT. DeWeerd, James H.; Colby, Malcolm Y. Jr. (Mayo Clinic, Rochester, Minn.). J. Amer. Med. Ass., 199: 109-11(Jan. 9, 1967).

Effects, side-effects, and complications of radiotherapy are reported in 32 patients receiving ^{60}Co γ radiation or 6-MeV x-ray treatment for bladder carcinoma, followed by surgery. The possibility was explored that irradiation of bladder cancer cells by less than cancericidal doses might alter the ability of cells to reproduce locally or at distant sites at the time of surgery. In general, the total tumor dose was about 4800 rad given in two sessions, both 12 to 14 days' duration and separated by a rest interval of 3 weeks. About 6 weeks after the completion of radiotherapy, total or segmental cystectomy and partial pelvic lymphadenectomy were carried out. Side-effects of irradiation included varied degrees of bladder and rectal irritative symptoms in most patients that persisted for as long as nine months. (BBB)

8623 EYE-SURVEY STUDY OF NUCLEAR-REACTOR WORKERS. Voelz, George L. (Atomic Energy Commission, Idaho Falls, Idaho). J. Occup. Med., 9: 286-92(June 1967).

The results of a 13-yr special slit-lamp eye-examination program on nuclear reactor workers are described. A total of 1424 special eye examinations, performed to detect early lens pathology, were done on 847 individuals. About 95% of the examinees were male and 84% were under 40 yr of age. A summary of penetrating radiation exposures recorded by film badges and nuclear-tract film showed that the average exposures of reactor personnel are low compared to estimated minimal cataractogenic doses. The maximum individual exposure was 25.3 Rem, which is 5% or less of the minimal cataractogenic dose for chronic exposure. The average exposure was found to increase with age, as expected, because of exposure time. No lens changes related to occupational radiation exposure were found. The need for such special eye examinations in radiation workers appears to be limited to a few special circumstances in which the radiation exposures are particularly difficult to measure. Medicolegal problems due to cataracts that are clinically similar to radiation-type cataracts can arise in any person in radiation areas. Four illustrative cases are described. It is essential to have well-documented personnel and plant radiation records which will give reliable dose determinations for employees. Periodic physical examinations on all radiation workers should include an ophthalmoscopic examination of the eye with particular attention to the lens, regardless of exposure history. (BBB)

8624 CHANGES IN THE EFFECT OF SOME INHALATION ANESTHETICS DURING TRICHLOROTRIETHYLAMINE INTOXICATION. Kroutil, M. (Palacky Univ., Olomouc, Czech.). Cesk. Fysiol., 16: 271-2(May 1967). (In Czech).

With all the drugs used, the period of awakening from anesthesia was lengthened. Trichlorotriethylamine influences the susceptibility of the organism towards inhalation anesthetics, and broadens their effect. In irradiated animals it also influences the effect of ether. (JPRS)

8625 ESTABLISHING THE HEREDITARY CHANGES AND CERTAIN PHYSIOLOGICAL AND BIOCHEMICAL CHANGES IN THE PROGENY OF RABBITS TREATED WITH RADIOACTIVE ^{131}I. Konstantinov, G.; Eftimov, B.; Aleksiev, D. (Georgi Dimitrov Higher Agricultural Inst., Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 485-7(1967). (In Russian).

Both sex and somatic cells are affected by radioactive irradiation. Hematopoiesis proved to be the most sensitive. Hereditary changes and a number of physiological and biochemical changes were sought in the generations of thoroughbred rabbits of the Chinchilla, Belgian Giant, and Vienna Blue breeds treated with 5 and 10 μCi radioactive ^{131}I. Results present in this article cover hemoglobin, erythrocyte, and leukocyte counts, catalase in the blood serum, iodine content in the blood serum, macroscopic and microscopic evaluation of the seminal fluid, biological control of the spermatozoa, protein fractions of the seminal fluid, as well as the results of the individual combinations and characteristics of the generations. (JPRS)

8626 EXPERIMENTAL ALLERGIC ENCEPHALOMYELITIS IN AGAMMAGLOBULINEMIC CHICKENS. Blaw, Michael E.; Cooper, M. D.; Good, R. A. (Univ. of Minnesota, Minneapolis). Science, 158: 1198-1200(Dec. 1, 1967).

White Leghorn chickens were subjected to bursectomy and whole-body irradiation at hatching, thus rendering them agammaglobulinemic. At four weeks of age, these chickens and control chickens received lyophilized bovine spinal cord emulsified with complete Freund's adjuvant. Agammaglobulinemic chickens developed the lesions of allergic encephalomyelitis with the same frequency and intensity as the controls. Our findings support the contention that antibodies are not necessary for the development of experimental allergic encephalomyelitis. (auth)

8627 EFFECTS OF RADIATION ON MEN AND MATERIALS. pp 107-50 of Radiation and Shielding in Space. Haffner, James W. New York, Academic Press, 1967.

Extraterrestrial radiations can produce undesirable effects on men and materials in space. Relative to these effects on man, discussion is presented of the mechanisms of interaction (in terms of atomic, molecular, and cellular effects), flux-dose relations in terms of RBE, the acute human response to radiation, the long-term human response (delayed effects and biological recovery), and biological protective measures. The cosmic radiation damage thresholds for various types of materials used in space flight and the problems involved in the application of the threshold values to spacecraft are discussed. 134 references. (E.R.B.)

8628 SUCCESSION OF GROWTH PHASES IN IRRADIATED AMOEBA. Chatterjee, Samar (Presidency Coll., Calcutta). Nucleus (Calcutta), 10: 23-7(June 1967).

The effect of x irradiation on the nature of clone formation in *Amoeba proteus* was examined in repeated subcultures following irradiation. Doses up to 15 KR had little effect on the clonal establishment of irradiated amoebae. Between the doses of 30 and 45 KR a rapid establishment of clones, which appeared much earlier than the controls, by the irradiated amoebae was noted. This accelerated phase persisted in the next 2 to 3 subcultures. Delayed clone formation restricted to only first subculture took place between the doses of 60 and 100 KR. At higher doses, viz., 125 to 150 KR, a total inhibition of clone formation was observed, many amoebae in the population dying. These results show that clonal establishment after x-ray exposure is a reliable criterion in determining the survival as well as post-irradiation fission rate in amoebae. With the standardization of methods for the establishment of clonal cultures, a more accurate end-point could be developed for studying some radiobiological effects in protozoa. (BBB)

8629 EFFECTS OF RADIOSTRONTIUM AND ROENTGEN RAYS ON GERM CELLS OF MALE MICE. Henricsson, B.; Nilsson, A. (Royal Veternary Coll., Stockholm. Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol., Ther., Phys., Biol., 6: 209-13(June 1967).

The lethal effect of roentgen rays on spermatogonia-A in inbred CBA mice is relatively high (LD_{50} = 12 to 25 R) if the cells have to pass several spermatogonial divisions, including type B-spermatogonia, before scoring. The effect of the administration of 0.7 μCi/g body weight of ^{90}Sr corresponds to about 12 R. When the cells do not have to pass these division phases, the effects in the range between 12 to 50 R seem to be similar and the sensitivity is lower, while the effects of ^{90}Sr between 0.1 and 1.4 μCi/g body weight show more linear pattern. (auth)

8630 MODULATED CEREBELLAR EVOKED POTENTIALS AFTER EXPOSURE OF THE CEREBELLUM TO ^{60}Co. Oishi, Yoshiyuki (Kobe Univ., Japan). Kobe J. Med. Sci., 12: 27-40 (Mar. 1966).

Cerebellar evoked potentials to superficial radial nerve stimulation were recorded in unanesthetized decerebrate cats by monopolar leads. After exposure of the cerebellum to 15,000 R of γ radiation from a ^{60}Co source the pattern changed definitely in shape and distribution, but not after 10,000 R. After 15,000 R radiation, positive-negative waves developed gradually all over the anterior lobe instead of localized positive spike in a part of the anterior lobe, and this was accompanied by marked spread of reflex muscle contraction. These changes reached a maximum at 4 to 12 hr, and then usually decreased in intensity. Under nembutal anesthesia these changes were suppressed. Similar changes as those after 15,000 R radiation were observed under α-chloralose administration, but local application of the drug on the cerebellum produced changes in the potentials, but not in reflex movements. The results are discussed in relation to the function of the granular layer in the cerebellum. (NSA of Japan)

8631 EXPERIMENTAL CRANIAL AND VASCULAR STUDIES OF THE EFFECTS OF PULSED AND CONTINUOUS WAVE LASER RADIATION. Fox, John L.; Hayes, Jude R.; Stein, Marvin N.; Green, Robert C.; Paananen, Roy (Veterans Administration Hospital, Washington, D. C.). J. Neurosurg., 27: 126-37(Aug. 1967).

A study of the effects of pulsed and continuous wave (CW) laser radiation on the intracranial and vascular structures in animals showed that very little total laser energy was needed to be immediately lethal for rodents and dogs, if it was focused to high energy-densities and delivered with enough power to be absorbed faster than the heat could be conducted away. The energy, which cannot penetrate deeply through scalp and skull, first must reach the closed intracranial cavity where a small volume of tissue is rapidly converted into gas, causing explosive herniation of the brain through the tentorial notch and foramen magnum. Fluorescent tracer studies indicated that the brain stem was the site of maximum blood-brain barrier injury, especially the pons and its respiratory center. Irradiation of the open brain with laser energy of greater magnitude (due to absence of the energy-attenuating skull) was not immediately lethal since the explosive vapors generated upon laser-brain interaction were dissipated into the open air. The 4-W argon CW laser emitting coherent light in the blue-green spectrum was also investigated. The focused energy could cut through skin readily because the soft skin edges could be retracted, exposing progressively deeper layers for tissue vaporization. Only 3 mm of skull bone could be penetrated in attempting to do a craniotomy, due to the inability to retract the hard bone edges. The dry, carbonized tissue in the incision absorbed and re-radiated the energy, and thus prevented deeper penetration. The higher power N_2-CO_2 gas laser emitting in the far ir overcame this limitation. (BBB)

8632 SEQUELAE OF AN EXCESSIVE RADIATION DOSE TO THE NECK. A CONTRIBUTION TO THE BILATERAL CAROTID OCCULSION SYNDROME. Liegl, Otmar (Staedtische Krankenhaus, Berlin-Neukoelln, Ger.). Z. Kreislaufforsch., 56: 221-33(Mar. 1967). (In German).

A man aged 53 yr developed an extreme lack of circulation in both eyes (ophthalmoangiopathia hypotonica), including secondary manifestations caused by occlusion of both carotids, verified by contrast medium studies. Occlusion of the carotids resulted from excessive irradiation of cervical lymph nodes on both sides that was performed at the age of five. The overdosage caused radiodermatitis with shrinking of skin and upper cervical organs. About six months later a tracheotomy became necessary. The late subsequent ophthalmological phenomena were noted after a latent period of 45 yr: progressive diminuation of the retinal vascular supply, with atrophy of the retina and the optic nerve after a transitory increased capillarization and appearance of microaneurysms; bilateral rubeosis iridis, with ophthalmoplegia interna on the right side; secondary glaucoma by occlusion of the chamber angle; and right-sided cataract. Pathogenesis of these radioinduced complications are discussed in terms of the importance of the eyes as the last field in the compensating circulation via circulus arteriosus cerebri, by retrograde filling of the intracerebral carotis interna; the absence of an increase in pressure (usually neurogenic hypertension would be expected in the absence of the carotid sinus); and the disproportion between retinal blood pressure and the intraocular pressure that additionally aggravates deficiencies in the intraocular circulation. To improve this condition, cataract extraction with wide iridectomy was performed on the right side. An iridencleisis was performed on the left side. There were no other radioinduced sequelae observed, especially those concerning the central nervous system. The radioresistance of the great vessels is discussed. (BBB)

8633 CENTRAL NERVOUS SYSTEM EFFECTS OF LASER RADIATION. Earle, Kenneth M.; Carpenter, Stirling; Roessmann, Uros; Ross, Martin A.; Hayes, J. R.; Zeitler, Elmar (Armed Forces Inst. of Pathology, Washington, D. C.). Fed. Proc., 24: Transl. Suppl. 14, 129-42(Jan.-Feb. 1965).

The effects of focused and unfocused ruby laser radiation upon the scalp, cranium, and brain of mice and rats were studied. With an unfocused beam, no gross or microscopic lesions of the brain parenchyma were produced when the beam was directed onto the intact scalp and cranium. When the beam was focused, most of the mice died within minutes if the output was about 20 to 40 J. Similar lesions were produced in rats, but were not immediately fatal. Also in the range of 20 to 40 J, subdural hemorrhages of the brain were produced with a focused beam. About 9% of a 30-J beam was transmitted into the brain through the hair, scalp, and cranium of the mouse. About 0.05% of a 30-J beam was transmitted through the entire head when focused to strike a calorimeter placed on the other side of the head. These experiments suggested that the human hair, scalp, and skull would be sufficiently thick and dense to protect the brain from focused or unfocused laser radiation up to the 40-J output and probably much higher energies, but the brains of small animals such as rats and mice can be severely damaged by a focused beam that is partially transmitted through the scalp and skull. (BBB)

8634 INTRODUCTORY STUDY ON THE FITNESS OF MICROCYTHAEMIC PERSONS FOR WORK INVOLVING EXPOSURE TO IONIZING RADIATION. Strambi, E.; Righi, E. Med. Lavoro, 56: 664-72(Oct. 1965).

The incidence of microcythemia among 1,000 workers in an Italian nuclear research center was found to be 1.5%. In the light of various radiobiological considerations and of the particular susceptibility evidenced by the hemopoietic system of heterozygotic thalassemic persons occupationally exposed to certain industrial poisons, it is recommended that caution be exercised in making medical pronouncements on the fitness of microcythemic persons for work involving exposure to radiation. They point to cases in which special restrictions and more frequent clinical supervision were ordered. Taking the view that such a approach may be too restrictive, the possibility that such persons might withstand the harmful effect of radiation better than do persons with a normal blood picture is discussed. It is concluded that greater attention should be paid to the supervision of microcythemic persons exposed to ionizing radiation and to the early identification of such persons. (Occup. Safety and Health Abstr.)

8635 BONE SARCOMAS FOLLOWING EXTERNAL IRRADIATION. Solheim, P. O. (Norwegian Radium Hospital, Oslo). Acta Radiol., Ther., Phys., Biol., 6: 197-201(June 1967).

Two cases of malignant bone tumours following roentgen therapy diagnosed by clinical roentgenologic and histologic investigations are reported. More than 30000 patients were treated in the hospital since 1932. One of these developed an osteogenic sarcoma in bone which was unaltered by disease at the time of irradiation. This frequency is very low compared to animal experiments where tumour incidence is 20 percent or more. The ages of the patients reported were 40 and 42 respectively. The tumour sites were in the ilium and sacrum. The latency period was 8 years in both cases. The radiation doses were 2800 ± 700 R for 46 days and 4300 ± 500 R for several months. (auth)

8636 RESEARCH ON THE ONTOGENETIC DEVELOPMENT AND ON THE EMBRYONAL ENERGY METABOLISM OF NORMAL AND X-RAY IRRADIATED GALLUS DOMESTICUS. Oprescu, St.; Voiculescu, I.; Constantinescu, Olga. Rev. Zooteh. Med. Vet., 17: No. 8, 28-36(Aug. 1967). (In Rumanian).

The development of chicken embryos in eggs irradiated prior to incubation was studied. Small doses of radiation such as 20 R shortened the incubation and had no damaging effects on the eggs, while doses of 100 and 200 R inhibit the development of the embryos and delay hatching. The delay is explained by the decreased rate of energy metabolism shown by irradiated eggs after the first 15 days of incubation. The 100 and 200 R doses have a damaging effect on the embryo. (auth)

8637 PREDICTION OF BIOLOGICAL DAMAGE FROM STOPPING-POWER THEORY. PART I. INCIDENT PARTICLES. Davy, D. R. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Health Phys., 13: 1159-74(Nov. 1967). (ORNL-P-2247).

With the initial assumption that the necessary and sufficient condition for biological damage to result from irradiation is the ionization of neighboring critical sites, stopping-power theory is used to develop a series of equations that successfully predict biological effect. With certain restrictions on the range of the velocity of incident charged particles, the equations simplify to: Biological effect/unit fluence

$$= \frac{Vb}{2w^2}\left[\frac{dE}{dx}(1 - F(T))\left(1 - \frac{b}{w}\frac{dE}{dx}(1 - F(T))\right)\right]^2$$

where $F(T) = \left\{\frac{\ln (2mv^2/T_d)}{2 \ln (2mv^2/I)}\right\}\left\{1 - \left(\frac{1 - T_d/2mv^2}{\ln 2mv^2/T_d}\right)^2\right\}^{1/2}$.

V is the critical volume of the biological system under consideration, b the C–H bond spacing, w the energy expended by the radiation in producing one ionization, m the electron mass, I the ionization potential of tissue, and dE/dx and v are the stopping power and velocity of the incident particle, respectively. T_d is the energy of the secondary electron whose range in tissue is equal to the dimensions of the diffusion volume around the critical sites. The application of the equations to human cell irradiations, biological criteria being colony-forming ability, predict RBE values in good agreement with reported results and involve values of V and T consistent with the physical properties of the cells. The variation of T with the degree of the biological end point observed in these and other systems is discussed. The extension of the above equation to irradiations with neutral particles is presented. It is shown that in the case of neutron irradiations dose concepts based on absorbed energy are not very useful. (auth) (UK)

8638 DAMAGE TO AND RESTORATION OF THE HEMOPOIETIC FUNCTION OF RATS UNDER CONDITIONS OF NONHOMOGENEOUS X-RAY IRRADIATION. Avetisov, G. M. Radiobiologiya, 7: 470-2(1967). (In Russian).

Rats were subjected to general irradiation with an $LD_{50/30}$ dose of x-rays under varying conditions of spatial homogeneity, as determined by dosimetric measurements on phantoms. Although the final result with respect to the survival ratio was the same in every case, distinct differences depending on the degree of homogeneity were observed in regard to damage to hematopoietic functions and the restoration of these functions after irradiation. (JPRS)

8639 SOME DATA ON THE APPLICATION OF INSULIN IN ACUTE EXPERIMENTAL RADIATION SICKNESS. Barkalaya, A. I. Radiobiologiya, 7: 404-6(1967). (In Russian).

Examination of the liver of rats irradiated at doses of 600–750 R indicated that the dynamic balance of carbohydrate-fat metabolism in the liver was disturbed following irradiation: the content of glycogen in the liver decreased and that of lipids increased with the result that fatty dystrophy of the liver occurred. Administration of insulin to the irradiated rats in doses of 0.2 unit/kg per day preserved a high glycogen level in the liver and prevented development of fatty dystrophy of this organ. (JPRS)

8640 COMPARATIVE CHARACTERISTICS OF SEASONAL CHANGES IN THE RADIATION SENSITIVITY OF ANIMALS. Darenskaya, N. G.; Pravdina, G. M.; Zagorskaya, I. B. Radiobiologiya, 7: 407-10(1967). (In Russian).

Rats and rabbits were irradiated with γ-rays and dogs with x-rays at doses of 300 to 900 R. For each species of animal, the variation of LD_{50} in relation to the month of the year was determined. There was no pronounced variation for rats. For rabbits and dogs, sinusoidal curves were obtained. For rabbits the average value of LD_{50} was 530 R during the year, with a minimum sensitivity in January (LD_{50} = 615 R) and a maximum sensitivity (LD_{50} = 440 R) in July. For dogs (average value of LD_{50} = 428 R during the year) the minimum sensitivity (LD_{50} = 455 R) was in March and the maximum sensitivity (LD_{50} = 385 R) in September. There was a direct correlation between the LD_{50} curves and those of the humidity of the air in Moscow, where the experiments were carried out, and an inverse correlation between the LD_{50} curves and those expressing variations in the amount of sunshine and the temperature during the year. Because biological functions of animals also vary along sinusoidal curves during the year, a connection between these functions and radiation sensitivity could be assumed. (JPRS)

8641 EXPERIMENTAL STUDIES ON THE EFFECT OF THERMAL SPRING BATHINGS ON DISTURBANCES INDUCED BY GAMMA-RAY IRRADIATION. Yamada, Tomi (Kyushu Univ., Japan). Onken Kiyo, 18: No. 2, 106-44(June 1966). (In Japanese).

Groups of rabbits irradiated by LD_{50} of ^{137}Cs (500 R) were subjected to full bathing in various spring waters for two weeks. Changes in body weight, serum thiol level, and nucleated bone marrow cell count were observed. The results were compared to that of cysteamine injection. Seasonal differences in response to bathing and drug were also examined in spring and autumn in the same manner, except for the dose of cysteamine injected. In the experiment performed in spring, compared to that in autumn, mortality rate of the irradiated rabbits was higher and the results were more unstable; nucleated cell counts were relatively high; and serum thiol levels were low. Changes induced by γ irradiation showed a somewhat larger variety in the spring experiment, the data being scattered in a wide range. In the spring experiment, some rabbits showed decreased nucleated cell counts even after two week's consecutive spring bathings, though the observed values were still higher than the previous values of the autumn experiment. A radioinduced decrease in serum thiol levels was more profound in the spring experiment, which however showed such a rapid recovery by bathing that previous levels were attained or sometimes exceeded after two weeks. On the radioinduced depression in body weights and nucleated cell counts, bathing in the Genbaku-center spring water showed an inhibitory action that closely resembled the effect of cysteamine injection. This was observed in spring and in autumn as well. As far as the inhibitory effects on the radioinduced depression of serum thiol levels and nucleated cell counts were concerned, the Onken-spring and that of the Yu-no-Hana were identical. The latter showed some superiority in restoring the body weight loss and the bone marrow cell depletion. From the fact that those restorative effects became evident in a week of bathing, a role of rare substances beside the thiol effect of the springwaters might be considered to play a part in the findings. A more stable result was thus obtained in the autumn experiment and the effect of bathing in the Genbaku-center spring was found almost identical with that of cysteamine injections of 25 mg/kg seven times every other day. Cysteamine injected 40 mg/kg for seven times showed nearly a complete inhibition on the radioinduced depression. Even acute disturbances induced by γ irradiation were counteracted by bathings in the thermal spring waters tested, presumably through the thiol effect, effect of rare substances, such as cobalt, and the so-called normalizing effect of spring waters. This may suggest that more remarkable recovery would be expected with thermal spring bathings in a chronic phase of the disturbances. (NSA of Japan)

8642 EFFECT OF X AND γ RADIATION ON THE DEVELOPMENT OF UNMATCHED GYPSY MOTHS (OCNERIA DISPAR L., LYMANTRIIDAE, LEPIDOPTERA). Kakhmanyuk, F. S.; Petryna, M. F. Vestsi Akad. Navuk BSSR, Ser. Biol. Navuk, No. 2, 98-104(1967). (In Belorussian).

The irradiation of caterpillars of unmatched gypsy moths with x and γ radiation at doses up to 500 R causes both a stimulating effect in the growth and development of the caterpillars as well as sterility (partial) of the developing males and females. The moths developing from irradiated caterpillars were quickly mated and as a result dark-colored individuals appeared more often. Irradiation at doses of 500 to 5000 R did not cause externally any more deviations from the control caterpillars, but the sterilizing effect appeared sooner. The irradiation of caterpillars at doses above 5000 R had a depressing effect on the growth and development and caused a significant increase of the sterilized individuals. A larger number of light-colored individuals characterized by a low stability with respect to disease and changes in the abiotic factors occurs. X radiation has a more depressing effect than γ rays at all dose. (tr-auth)

8643 EFFECTS OF IONIZING RADIATION ON BONE GROWTH IN THE RAT. **Phillips, Richard Dean. Berkeley, Calif., University of California, 1966. 121p.**

Thesis.

The effects of ionizing radiation on the linear growth of the femur, tibia, and tail were determined in male Sprague-Dawley rats by the roentgenographic technique. The early and long-term effects of x irradiation on skeletal growth were investigated with respect to the age at exposure. Rats exposed at a juvenile age (37 days) to a sublethal dose (430 rads) exhibited a retardation in femur, tibia, and tail growth within 14 days after exposure. The maximum deficit was attained within 30 days after exposure and remained approximately constant for the next 300 days. In animals that were irradiated as young adults (101 days of age), femur and tibia lengths did not differ from those of controls for the first two months after exposure. However, there were deficits in femur and tibia lengths in these animals at the end of life span. The magnitude of the bone length reduction at the end of life span was dose dependent. The two major differences in response between the two age groups were the time course of the radiation effect on growth and the magnitude of the deficit. The reduction in bone length occurred faster and was greater in the younger irradiated group. In a subsequent experiment, the long-term effects of neutron exposure on bone growth were determined. Femur, tibia, and tail lengths of neutron exposed animals were shorter than those of controls at the end of life span. The magnitude of the bone growth deficits varied directly with dose and were greater in animals exposed as juveniles than in animals exposed as young adults. When the effects produced by neutron exposure were compared to those produced by x irradiation, a neutron to x-ray RBE of about two was obtained. The quantitative aspects of bone growth retardation in rats at 60 days after x irradiation were determined with respect to radiation dose and age at exposure. The decrement in bone growth increased exponentially with a linear increase in dose within the range of 100 to 680 rads. The bone growth decrement was also a function of the age of the animal at the time of exposure; the logarithm of the decrement was a linear function of the reciprocal of age for animals exposed during the rapid phase of bone growth. The information obtained from the dose-response and age-response relationships was used to derive an equation that could be used to predict the bone growth decrement occurring 60 days after x-irradiation on the basis of the age at exposure and the radiation dose. The general equation was: Bone growth retardation $= k \times 10^{m(\text{dose})+n(1/\text{age})}$. Values for k, m, and n were determined for the femur and tibia and found to give a good estimation of effect within the dose range of 100 to 680 rads for exposure ages of 24 to 58 days. Radiation-induced retardation of femur and tibia growth was determined in young male rats at 60 days after whole- or partial-body exposure to 450 R of x rays. Approximately 52% of the growth reduction was attributed to local irradiation of the limb, and the remaining 48% was ascribed to a systemic irradiation effect. The systemic response was not dependent on the mass of tissue irradiated, nor on the decreased food intake after irradiation. The region of the animal exposed, however, did appear to be important. By exposing various regions of the body, the systemic response was subdivided into abscopal components. Irradiation of the head, abdominal, and thoracic regions yielded 42%, 40%, and 18%, respectively, of the total systemic effect. The local and abscopal responses appeared to be additive rather than synergistic, with the total radiation effect the resultant sum of the local and abscopal components. (Disser. Abstr.)

8644 RASPREDELENIE I BIOLOGICHESKOI DEISTVIE RADIOAKTIVNYKH IZOTOPOV. SBORNIK STATEI. (Distribution and Biological Effect of Radioactive Isotopes. An Anthology). **Moskalev, Yu. I. Moscow, Atomizdat, 1966. 575p.**

Knowledge of the patterns of distribution and biological effect of radioisotopes as a function of their pathways and rates of penetration into the organism is the best criterion for determining their maximum permissible doses, developing means of the prevention and therapy of injuries caused by various radioisotopes and refining the principles of differential diagnostics. Thus the patterns of distribution and biological effect of such principal radioisotopes as ^{137}Cs, ^{45}Ca, ^{89}Sr, ^{90}Sr, ^{91}Y, ^{144}Ce, ^{233}Pa, ^{239}Pu, ^{232}Th, ^{131}I, ^{3}H, ^{60}Co, ^{59}Fe, ^{95}Zr, ^{35}S, ^{111}Ag, ^{198}Au, etc., are considered, along with the physico-mathematical aspects of their metabolism in man and animals. Factors enhancing or reducing the build-up of isotopes in various organs of the body are analyzed. It is shown that functional shifts in various systems may arise even earlier than in the critical organs. The role of additional pathological factors in the long-term consequences of poisoning with radioisotopes is examined, as is the effect of radioisotopes on fertility and the growth of offspring. Special attention is paid to the biological effect of tritium oxide and ^{210}Po. The results of research into ways and means of accelerating the elimination of radioisotopes by the organism and reducing their absorption from the gastrointestinal tract are presented. Physico-chemical approaches to the selection of organic compounds intended to eliminate radioactive substances from the organism by forming soluble complexes with the latter are analyzed. (TSS)

8645 THE LIFE SPAN SHORTENING EFFECT OF IRRADIATION: AN INVESTIGATION OF THE INTERRELATION OF PREMATURE DEATH AFTER IRRADIATION, DEATH UNDER LONG-PROTRACTED IRRADIATION, AND THE REDUCED ACUTE LETHAL DOSE IN OLD AGE. **Strong, Loretta Higgins. Rochester, N. Y., Univ. of Rochester, 1966. 204p.**

The well known life span shortening effect of radiation was compared to a premature aging; this conclusion is based on the condition of the animals at death and on disease incidence among animals surviving irradiation. If irradiation duplicates the effect of natural aging the two should be additive; not only should irradiation reduce the ability of the animal to withstand the effects of aging, but aging should also reduce the ability of the animal to withstand radiation. This latter result is found experimentally. Less radiation is needed to kill an animal acutely as the animal ages, since LD50/30 declines after middle age in the rodent. Similarly, a dose of radiation previously given to the animal is found to reduce the amount of radiation needed in a second dose to effect 50% mortality. Thus radiation dose and aging are seen to behave similarly in these ways: apparently both reduce general resistance, leading to death, and both reduce radio-resistance. The purpose of this study was to quantitate these effects. The shape of the dose response curve (radiation dose versus mean life span) after single doses and the magnitude of the response were determined mainly in two species, rat and mouse, using a wide variety of strains in the mouse. The dose-reducing effect of various treatments, e.g., fractionation, chemical protection were studied. The shape of the dose response curve (dose versus mean life span) and the magnitude of the response for small daily doses given until the death of the animal (protracted irradiation-to-death) was studied, first for x and γ ray doses. If this dose response curve had adequate data for the early half of normal unirradiated mean life span constants can be determined that enable us to estimate the unrepaired injury to the animal at the time of death. The magnitude of these constants, permanent or irreparable injury and repair rate, are compatible with the results of split dose experiments (see above) and the calculated unrepaired injury at death is compatible with the reduction in LD50/30 in later life. The magnitude of the constants and the reduction in LD50/30 in later life is not compatible with the life span shortening effect of single doses; the latter response indicates a much greater degree of damage to the animal. It was hypothesized that the injury due to aging or to radiation is self-magnifying. This hypothesis was shown to be compatible with the shape of the dose response curves and with the magnitude of the response for single dose life span shortening effect. The hypothesis was not compatible with the results on animals pre-irradiated with single doses, then given protracted irradiation-to-death. Moreover, this hypothesis did not take into account two other experimental results; that neutron protracted irradiation-to-death did not show the same results as x and γ irradiation, i.e., the damage was apparently as great under this regime as with single doses, and that fractionation of a dose of x and γ rays (in experiments where the animals were not irradiated-to-death) reduced the life span shortening effect, whereas fractionation of a dose of neutrons did not. The pertinence of this dose reducing effect of fractionation of x and gamma radiation dose was discussed. (Disser. Abstr.)

8646 RADIATION INDUCED AVERSIVE CONDITIONING AND THE OLFACTORY BULBS. **Watson, James Allen. Athens, Ga., Univ. of Georgia, 1966. 56p.**

Thesis.

The role of the olfactory bulbs as a potential receptor mechanism in radiation induced aversive conditioning was investigated. Garcia, Kimeldorf and their co-workers have shown that an animal radiated while consuming a particular fluid will avoid the fluid for several days after the exposure. A variety of animals and stimuli were used to demonstrate this phenomenon. The receptor mechanism involved in animal detection of low dose radiation was not known. Receptor mechanisms that were investigated in the past are as follows: gastrointestinal disturbances, radiation-induced phosphenes in the eye, blood pressure, heart rate, respiration rate, and deep colonic temperature. The central nervous system was investigated recently. A hypothesis expressed by Garcia and his followers was that the receptor involved in detection of radiation by animals was the olfactory bulbs. This experiment tested their hypothesis. In Experiment I twenty rats have their olfactory bulbs removed. A sham-operation was performed on twenty control subjects. The primary aim of Experiment I was to test behaviorally the anosmia produced by olfactory bulb removal. The criterion of anosmia was a behavorial demonstration in a conditioning runway that the operated animals could not smell an avoidance stimulus, oil of wintergreen. The control group was used as the standard of comparison. Experiment II was designed to demonstrate radiation induced aversion to saccharin by normal and anosmic animals. This was done by selecting an experimental group of fifteen anosmic animals represented by those who scored highest on the conditioning test in Experiment I. The fifteen control animals were selected randomly from the earlier control group. After the animals were assigned to their groups, a saccharin stabilization period was given for five days. From 1000 to 1400 each day two drinking bottles were presented to the subjects. One bottle contained tap water and the other was filled with a 0.1% solution of saccharin. All animals established a preference for the saccharin solution. The day following the saccharin stabilization period, the subjects were given access to one bottle containing saccharin solution and were exposed to x radiation. Both the anosmic and sham-operated animals received 60 R over a four hour drinking period. At 1400 the x radiation was terminated and all drinking bottles were removed immediately from the cages. At 1000 the following day the subjects began a twenty hour deprivation—four hour drinking period schedule. During the drinking period both groups had access to both saccharin and water. This procedure was continued until extinction had occurred and the post-irradiation level of saccharin consumption approximated its pre-irradiation level. Following extinction post-mortem examinations of the brains verified the completeness of the olfactory bulb removal. The results of the study showed that aversive conditioning to the saccharin solution was demonstrated only by the control subjects. Anosmic animals continued to show a high preference for the saccharin solution in all post-irradiation trials. A conclusion can be drawn that the olfactory bulbs are involved in radiation detection in this test. (auth)

8647 EFFECTS OF RADIATION ON THE AUTOTRANSPLANTATION OF BW11301 MOUSE TUMOR. Bramlet, Roland C. Jamaica, N. Y., St. John's Univ., 1966. 118p.

Thesis.

A study of the effects of irradiation upon the spread of a mouse tumor is presented. Reports in the literature indicate that irradiation of a primary tumor may possibly, under certain circumstances, promote its metastatic spread. This possibility was investigated through the creation of artificial metastases by autotransplantation from irradiated primary tumor implants. Implants of an anaplastic mouse tumor (BW11301) were made into the hind legs of A/J and C3H/HeJ mice. When the implants reached a size of one centimeter they were irradiated with various amounts of x ray. Following irradiation, fragments were removed from the irradiated primary tumors. These fragments were reimplanted upon the back and chest of the hosts from which they came. These secondary autotransplants were then observed for growth. In a control group of A/J mice with no apparent resistance to the tumor one hundred percent of the primary implants and ninety-two percent of the autotransplants were successful. In a similar group irradiated with five hundred roentgens eighty-two percent of the autotransplants succeeded. One group of A/J mice was found that appeared to offer a slight immunological resistance to the tumor. This resistance was indicated by regression of the primary tumors in some (10/42) animals after a period of time although all primary tumors grew at first. In these animals forty-five percent (19/42) of the autotransplants grew. A similar test group was given five hundred roentgens of x ray locally to the tumor before autotransplantation. In these individuals sixty-eight percent (21/31) of the autotransplants demonstrated growth. In C3H/HeJ mice, that have a moderate immunological resistance, only seventy percent of the primary tumors were able to invade the host. Only an occasional success was encountered in autotransplants made in positive C3H/HeJ animals. As a test procedure primary tumors in C3H/HeJ mice were given five hundred or four thousand roentgens of x ray. None of the autotransplants made following either of these treatments were successful. These experiments show that in a nonresistant host local irradiation of the primary BW11301 tumor at any dose level inhibits the ability of the autotransplants to take. Irradiation of the tumor in a host with a moderate immunological resistance also reduces the possibility of autotransplant success. Local irradiation of the tumor with five hundred roentgens in mice with a slight resistance to the tumor gave a different result. In this situation autotransplants from irradiated primary tumors grew better than autotransplants from nonirradiated controls. This finding implies that local irradiation of the BW11301 tumor in situ reduced host resistance without significant damage to the tumor. (Disser. Abstr.)

Radiation Effects on Plants

Refer also to abstracts 8440, 8448, 8482, 8494, 8500, 8501, 8503–8505, 8507, 8508, 8510, 8511, 8539, and 8600.

8648 CORRELATIONS BETWEEN PERIODICITIES IN GERMINATION OF CHENOPODIUM BOTRYS AND VARIATIONS IN SOLAR RADIO FLUX. Cumming, Bruce G. (Univ. of Western Ontario, London, Can.). Can. J. Bot., 45: 1105-13 (July 1967).

Evidence for an effect of sunspot activity on germination of seeds is presented. Pronounced fluctuations were noted in the percentage germination of seeds that were kept in darkness under carefully controlled conditions of temperature, humidity, and barometric pressure. Germination tests were conducted for two yr in controlled environment. The fluctuations in percentage germination showed no correlation with relative humidity, barometric pressure, lunar cycle, or magnetic intensity. However, highly significant correlations were observed between fluctuations in germination of solar radio flux (10.7 cm wavelength, indicative of sunspot activity). The effect of solar flux on germination (whether direct or indirect) was greatest during the week immediately preceding the wetting of seeds. Periodogram analyses of the periodicity of percentage germination and solar flux provided corresponding peaks, showing that the component periods for solar flux are practically the same as those for germination. Whether these correlations were indicative of a direct effect of solar radio flux on germination cannot yet be affirmed. It is suggested that future studies should include experimental modification of electric potential during storage of seeds and during germination tests. (BBB)

8649 THE EFFECTS OF GAMMA RADIATION ON GERMINATION AND SEEDLING DEVELOPMENT OF YUCCA BREVIFOLIA ENGELM. Johnstone, G. R. (Univ. of Southern California, Los Angeles); Klepinger, F. W. Radiat. Bot., 7: 385-8 (Oct. 1967).

Three seed crops (1960, 1963 and 1964) of Yucca brevifolia Engelm. were irradiated with 1000 kR γ-rays from ^{60}Co. Test lots of 100 seeds for each control and exposure were planted in ceramic containers equipped for subirrigation. Five short-term experiments were terminated to measure the shoots and roots for shoot-root ratio computations. The trends of these ratios expressed as decimals gradually increased with increasing levels of irradiation, indicating that the roots are more radiosensitive than the shoots. This excessive root inhibition of growth would limit the survival of the species in its natural desert habitat. Graphically represented results of a long-term experiment showed that survival percentages relative to controls varied with the time factor. LD_{50} for 53, 32, and 33 kR occurred at 30, 168, and 198 days, respectively. Total mortality occurred at 60 kR and above. (auth)

8650 CORRELATION BETWEEN RADIATION EFFECTS OF MEMBRANE POTENTIAL OF ELECTRIC STIMULUS THRESHOLD AND RESISTANCE OF THE CELL MEMBRANE IN NITELLA FLEXILIS. Hansen, U.-P. (Institut fuer Angewandte Physik, Kiel). Atomkernenergie, 12: 447-62(1967). (In German).

Short irradiation of cell membranes causes diminution of resting potential, threshold and resistance. The following investigations made on cells of the alga Nitella flexilis have verified that these phenomena are related and can be reduced to an enhancement of the passive permeabilities of the plasmalemma. The opinion is discussed that irradiation interferes with the mechanism of the Hodgkin and Huxley theory. This would mean that only the permeability of chloride-ions is increased (below 30 mV). The results of the investigations are correlated with the hypothesis of Vanselow. Beside this some pecularities are demonstrated e.g., very slow oscillations of the resting potential lasting for several hours. (auth)

8651 ROLE OF B IN THE NEOFORMATION OF ROOTS BY TOMATO CUTTINGS IRRADIATED BY THERMAL NEUTRONS. Ecochard, Rene; de Nettancourt, Dreux. Compt. Rend., Ser. D, 265: 748-50(Sept. 4, 1967). (In French).

The role of boron in the sensitivity of vegetable tissues to thermal neutrons comes from the high cross section of the isotopic component ^{10}B of this element. By modification of the ratio $^{10}B/^{11}B$ in tomato plants growing on nutritive solutions the sensitivity to thermal neutrons of the aptitude to rhizogenesis of slips taken from these plants is modified. (tr-auth)

8652 EFFECTS ON THE VITALITY OF WHEAT SEEDS OF TREATMENT WITH X RAYS AT THE PROEMBRYO STAGE. Scalfati, M. C.; Alessandroni, A. (Istituto Nazionale di Genetica, Rome). Genet. Agr., 19: 271-82(May 15, 1965). (In Italian).

Treatments with x-ray doses of 600 and 800 R were applied to proembryos of Tritium durum var. Reichembachi, Korn, c.v. Cappelli. Treatments were carried out on artificially pollinated ears 32 hours after pollination. Histological controls indicated that the developmental stage at treatment was at two to four cells. The treatment had no noticeable effects on seed formation. The germinability of the seeds obtained from treated ears was considerably reduced but there was no significant difference between the two doses. We also observed a delay in germinability and in the development of the first coleoptile, more marked with the higher dose of irradiation. The length of the first leaf and of the coleoptile, both of which were highly correlated, were affected by irradiation of the proembryos to a degree identical for the two doses. (auth)

8653 THE EFFECTS OF SEED TREATMENT WITH FAST NEUTRONS ON SOME MORPHOLOGICAL ELEMENTS OF M_1 SEEDLINGS IN VICIA SATIVA L. AND V. VILLOSA ROTH. Zannone, L.; Mariani, G. (Istituto Nazionale de Genetica, Rome). Genet. Agr., 19: 263-70(May 15, 1965). (In Italian).

The effects of seed treatment with fast neutrons at doses up to 6000 rep on seedling emergence and seedling development in Vicia sativa L. are reported. The effects of treatment with 800 and 1200 rep on the leaf size in V. sativa L. and V. villosa Roth, are also reported. The existence of a high correlation coefficient among different morphological seedlings characters was confirmed. The percentage emergence in the control was 97 to 99% up to 2400 rep, falling to 60% at 3200 rep and 18% at 4000 rep. (auth)

8654 USE OF IONIZING RADIATION FOR THE INTRODUCTION OF USEFUL CHARACTERISTICS IN INTERSPECIFIC AND INTERGENERIC HYBRIDS OF TRITICUM DURUM. Scalfati, M. C.; Alessandroni, A. (Istituto Nazionale di Genetica, Rome). Genet. Agr., 19: 224-42(May 15, 1965). (In Italian).

In order to attempt the introduction of agriculturally useful characters in Triticum durum interspecific and intergeneric hybrids, dormant seeds of the F_1 generation were treated with x rays. Progenies of the treated lines and progenies of the same lines untreated were bred together for comparison. Spikes or lines showing useful agronomical characters were selected, records being kept through several generations of the number of such spikes and lines in treated and nontreated stocks. Data are examined on the following characters; biological cycle, plant height, spike fertility, thousand seeds weight, percentage of shrivelled and yellow berried seeds. Height of straw and spike fertility seem to be the most influenced characters; the mean height of straw was subjected to a reduction that was maintained till the fourth generation, though with a 2 to 3 cm difference, fertility was largely reduced initially but gradually reached a plateau. The effect of treatment on spike fertility varies according to the species and genera represented in the combinations of crosses that were tested. (auth)

8655 ANALYSIS OF AN INDUCED MUTATION REDUCING SEED SETTING IN DURUM WHEAT. Bozzini, A.; Bagnara, D. (CNEN, Rome). Genet. Agr., 19: 209-23(May 15, 1965).

From seed of durum wheat (cv. Cappelli) treated in 1956 with thermal neutrons, a sphaerococcoid mutation was isolated, characterized by a very low seed setting. In the M_4 and M_5 selfed sphaerococcoid progenies some variability in seed setting was noticed. For this reason an attempt was made to select plus and minus variants for this character. However selection did not bring about a positive result, showing the genetical basis of this variability to be slight or there to be no genetic basis at all. A testcross of the mutant line to the mother line (Cappelli), together with data obtained from some natural cross-fertilization, indicated independence between the sphaerococcoid and the low seed setting factor(s). All possible combinations were obtained, segregation following the expected pattern for two independent recessive factors. Analyses of PMC meiosis and of pollen fertility did not show any cytological aberration. Several hypotheses may be advanced to explain the action of the seed, setting reducing factor; the most probable seem to be; an interference with the ontogenesis of the macrosporophyte, an inhibition of the fertilization process, an early degeneration of the embryo or of the endosperm. (auth)

8656 FACTORS MODIFYING THE EFFECTS OF IONIZING RADIATION IN LADINO WHITE CLOVER. Palenzona, D. L.; Ferrari, A. (Univ., Pavia, Italy. Stazione Sperimentale di Praticoltura, Lodi, Italy). Genet. Agr., 19: 199-208(May 15, 1965). (In Italian).

White clover seeds (ladino) were irradiated with doses of x ray ranging up to 40,000 R. Seeds were sown in pots soon after treatment and the resulting seedlings were transferred to an open field. From the stems of each adult plant 16 nodes were taken. In the next season the nodes were allowed to grow in the open; data on five quantitative characters were scored at ripening. Statistical analysis of those data has shown; that variability between plants increases according to the dose, in all the characters considered; that variability within plants is modified by the treatment, but in different ways according to the character, in number of stems, maximum height and length of central leaflet variability increases, in number of florents heads and width of central leaflet variability decreases with increasing radiation dose. In the discussion a comparison is made between the results obtained for variability within plants and the results for variability between plants. It is concluded that the modification of variability induced by x rays is dependent upon the metabolic pathway of the character considered. (auth)

8657 THE INFLUENCE OF SOME HEXITOLS AND SUGARS ON CO_2 PRODUCTION BY STARVED AND X-IRRADIATED, STARVED YEAST CELLS. Spoerl, Edward; Doyle, R. J. (Army Medical Research Lab., Fort Knox, Ky.). Can. J. Microbiol., 13: 811-17(Oct. 1967).

The rates of CO_2 production from glucose by x-irradiated and unirradiated yeast cells (incubated 21 hours in solutions of mannitol, ribose, methyl glucose, or cellobiose) were the same; but in a similar experiment, involving a 21-hour incubation in water, irradiated cells produced CO_2 at a higher rate than did unirradiated cells. Incubation of the cells with the above compounds also eliminated a lag period in CO_2 output and preserved a high capacity to produce CO_2. On the other hand, incubation with glucose or fructose, though it eliminated the lag, lowered the rate of CO_2 output and did not eliminate the difference in output between irradiated and unirradiated cells. Conversion of cells to spheroplasts also eliminated the radiation-induced difference in the rate of CO_2 production, and, because sorbitol was used as a stabilizing agent for the spheroplasts, suggested first that sorbitol and other hexitols and sugars be examined. Reincubation, after a 21-hour starvation in water, with any of the compounds tested removed the lag period, though CO_2 output was reduced. (auth) (Canada)

8658 SOIL ALGAL VEGETATION OF γ IRRADIATED FIELD AND NATURAL STRONGLY RADIOACTIVE DISTRICT IN JAPAN. Akiyama, Masaru (Shimane Univ., [Japan]). Shimane Daigaku Ronshu, Shizen Kagaku, No. 16, 126-34(Dec. 1966).

Soil algal vegetation in certain radioactive districts in Japan was studied by means of crude cultures of soil samples. The soils examined were obtained from a grassy plain in Ningyotoge, Tottori Prefecture and the experimental γ-irradiated field in Ohmiya, Ibaragi Prefecture. Thirty species of Chlorophyceae, five of Xanthophyceae, six of Bacillariophyceae, three of Cyanophyceae, and one of Euglenophyceae were identified in the soils of Ningyotoge, and fifty species of Chlorophyceae, two of Xanthophyceae, five of Bacillariophyceae, and six of Cyanophyceae were identified in the soil of the γ-irradiated field. It appeared that there is scarcely any differences in the algal composition of soil communities of natural radioactive districts and of γ-irradiated fields. A list of soil algae recognized in α- and γ-irradiated fields is given. (NSA of Japan)

Radiation Effects on Microorganisms

Refer also to abstracts 8482, 8492, 8493, 8499, 8502, 8519, and 8667.

8659 EFFECTS ON HOST-CELL RIBONUCLEIC ACID METABOLISM OF ENCEPHALOMYOCARDITIS (EMC) VIRUS EXPOSED TO ULTRAVIOLET IRRADIATION. Naftalin, Richard (National Inst. for Medical Research, London). Biochem. J., 105: 51(Dec. 1967).

It was concluded from the studies described that uv irradiation of encephalomyocarditis (EMC) virus, while rapidly inactivating its infectivity, does not halt the inhibition of cell RNA synthesis until the viral damage is such that it ceases to adsorb to the cell surface. This suggests that the origin of the inhibitory response is not viral but cellular. (auth) (UK)

8660 ROUS SARCOMA VIRUS PRODUCTION IN MIXED CULTURE OF MOUSE TUMOR CELLS AND CHICKEN EMBRYO FIBROBLASTS BY THE ADDITION OF UV-IRRADIATED HVJ. Yamaguchi, Nobuo; Takeuchi, Mieko; Yamamoto, Tadashi (Tokyo Univ.). Jap. J. Exp. Med., 37: 83-6(Feb. 1967).

Rous sarcoma virus (RSV)-induced mammalian tumor cells usually contain no directly demonstrable infectious virus, but infectious RSV can be recovered when the tumor cells or in vitro transformed cells are inoculated into young chickens or are cultivated together with chicken embryo fibroblasts (CEF). An ascites sarcoma, induced by the Schmidt-Ruppin strain of RSV (SR-RSV) transplantable in C3H/He mice, and cultured in vitro was used to study cell line derived from the persistence of viral genome in the tumor cells. Contrary to expectations, no infectious

RSV could be detected in the mixed cultures of the mouse tumor cells and CEF. However, by the addition of uv-irradiated hemagglutinating virus of Japan (HVJ) to the mixed cultures, infectious RSV could be recovered. Furthermore, by the use of γ-irradiated tumor cells, infectious RSV could be recovered from the mixed cultures. These experiments were done with the tumor cells treated with 2000 R of ^{60}Co γ radiation. Mixed cultures were carried out as in the first experiment but at each transfer a culture was divided into three parts and no CEF added. By adding uv-irradiated HVJ in the mixed cultures of γ-irradiated mouse tumor cells and CEF, infectious RSV could be recovered two to seven days after the initiation of mixed cultivation. In this experiment also, no infectious RSV was detected in the mixed cultures without HVJ or in the cultures of γ-irradiated mouse tumor cells infected with uv-irradiated HVJ. Frozen and thawed cell suspensions of the mixed cultures that contained infectious RSV not only induced sarcomas when inoculated into young chickens but also formed typical foci of SR-RSV in the agar media when inoculated in CEF cultures. (BBB)

8661 INACTIVATION AND DENSITY STUDIES WITH PARA-ADENOVIRUS 7 (SV40-ADENOVIRUS "HYBRID" POPULATION). **Butel, Janet S.; Rapp, Fred (Baylor Univ. Coll. of Medicine, Houston, Tex.). J. Immunol., 97: 546-53(Oct. 1966).**

Susceptibility of inactivation by uv light was determined for the components of the hybrid virus, as were uv inactivation rates for pure SV40 and adenovirus. Suspensions of PARA-adenovirus were irradiated with uv for various lengths of time and assayed for the two components. Preparations of SV40 were irradiated in a similar manner. The results showed that the PARA in the hybrid population was inactivated by uv more rapidly than the associated adenovirus. SV40 was more resistant to inactivation by uv light than either PARA or adenovirus. Approximately 99% of the plaque-forming ability of PARA was inactivated after exposure to uv for one min. Ultraviolet irradiation for the same duration inactivated about 92% of the infectious adenovirus 7 in the hybrid population and about 85% of the infectivity of the SV40 preparation. Results were also expressed as the 37% dose, that is, the dose of irradiation that leaves 37% of the virus population as a surviving fraction (e^{-1} = 37%). The average 37% dose was 12 sec for PARA, 22 sec for adenovirus 7, and 28 sec for complete SV40. Both PARA and adenovirus 7 in the hybrid population were equally sensitive to photodynamic inactivation after incorporation of either neutral red or proflavins. Neither component was affected by treatment with ribonuclease or deoxyribonuclease. Both members showed similar rates of heat inactivation at 50°C. The PARA and adenovirus 7 in the hybrid stock both banded at a buoyant density of 1.34 in CsCl. Except for sensitivity to inactivation by uv light, PARA could not be differentiated from adenovirus. (BBB)

8662 EFFECT OF MICROWAVES ON ESCHERICHIA COLI AND BACILLUS SUBTILIS. **Goldblith, Samuel A.; Wang, Daniel I. C. (Massachusetts Inst. of Tech., Cambridge). Appl. Microbiol., 15: 1371-5(Nov. 1967).**

Suspensions of *Escherichia coli* and *Bacillus subtilis* spores were exposed to conventional thermal and microwave energy at 2,450 MHz. The degrees of inactivation by the different energy sources were compared quantitatively. During the transient heating period by microwave energy, approximately a 6 log cycle reduction in viability was encountered for *E. coli*. This reduction was nearly identical to what is expected for the same time-temperature exposure to conventional heating. Heating of *B. subtilis* spores by conventional and microwave energy was also carried out at 100 C, in ice and for transient heating. The degree of inactivation by microwave energy was again identical to that by conventional heating. In conclusion, inactivation of *E. coli* and *B. subtilis* by exposure to microwaves is solely due to the thermal energy, and there is no per se effect of microwaves. (auth)

8663 SOME GROSS CHANGES IN PARTICLES OF TOBACCO MOSAIC VIRUS CAUSED BY LARGE DOSES OF ULTRAVIOLET RADIATION. **McLaren, A. D.; Kleczkowski, A. (Rothamsted Experimental Station, Harpenden, Eng.). J. Gen. Virol., 1: 391-4(July 1967).**

Doses of uv radiation much larger than needed to inactivate all detectable infectivity of tobacco mosaic (TMV) cause various changes in structure and properties of the virus protein, such as increased susceptibility to denaturation by heat, loss of the original antigenicity, and the breakdown of the rod-shaped virus particles first into shorter rods and then into amorphous masses. Some of these changes begin when the dose is such that the proportion of the original infectivity still remaining is about 10^{-4}. The changes shown by electron microscopy, and the rate and quantum yield of the change of protein subunits of the virus are reported. Gaps were seen in the walls of the virus particles, extending from the edge to the center of the particles and indicating that pieces had fallen out of the particles. The average length of the particles decreased progressively with increasing irradiation, the original particles breaking into shorter and shorter segments. Amorphous material gradually accumulated and when the dose of irradiation reached 4.65×10^{-5} einstein/cm^2 almost all the material was amorphous. To compute the quantum yield for such observed denaturation of protein subunits, their molecular weight was taken as 18,000. When 1.16×10^{-5} einstein/cm^2 had been delivered, the amount of energy scattered and absorbed by 0.1 mg of TMV, containing 5.3×10^{-9} moles of protein subunits, under each cm^2 of irradiated area, was about 0.58×10^{-5} einstein, of which $(0.6/3.0) \times 0.58 \times 10^{-5} = 1.2 \times 10^{-6}$ einstein was absorbed by virus protein. Assuming that there was no transfer of energy between virus protein and nucleic acid, the quantum yield was 0.0003. This value was less than $^1/_{10}$ of 0.0047, computed for A-protein in solution, suggesting that destroying a single amino-acid residue in a protein subunit is not sufficient to denature the subunit in the virus. Since a proportion of irradiated virus became nonprecipitable by trichloracetic acid even without incubation with trypsin, bonds were broken by irradiation. (BBB)

8664 PHOTOREVERSAL OF ACRIFLAVINE INHIBITION OF DEOXYRIBONUCLEIC ACID REPLICATION IN ULTRAVIOLET LIGHT-EXPOSED BACTERIA. **Doudney, C. O. (Univ. of Texas, Houston). Photochem. Photobiol., 6: 651-6(Sept. 1967).**

Acriflavine enhances both the lethal and mutagenic effect of uv light in bacteria, and prevents host cell reactivation, presumably by repressing the elimination of pyrimidine dimers from bacterial DNA. Photoreversal treatment after uv exposure was employed in a strain of *Escherichia coli* that had lost the capacity for photoenzymatic splitting of the pyrimidine dimer and a revertant strain that had regained this capacity. With the strain able to split the pyrimidine dimer, acriflavine prevented restoration of DNA replication after uv exposure even after photoreversal treatment. With a revertant strain possessing capacity for photoreversal response, light exposure prior to addition of the dye eliminated most of the blockage of DNA synthesis by the dye. These results show that the presence of dimer-containing regions in the DNA prevents restoration of DNA replication when the dye is present. However, the nonphotoreversibility of some of the uv damage responsible for blockage of DNA synthesis by the dye suggests that acriflavine also interacts with lesions not restituted by the photoreactivating enzyme. (BBB)

8665 INACTIVATION OF BIOLOGICAL INSECTICIDES BY IRRADIATION. **Cantwell, George E. (Dept. of Agriculture, Beltsville, Md.). J. Invertebr. Pathol., 9: 138-40(Mar. 1967).**

Tests were conducted to determine the amount of uv-induced inactivation of certain biological insecticides. Earlier tests indicated that over 50% of the spores of *Bacillus thuringiensis* var. thuringiensis were inactivated in 30 min; over 80% were inactivated in 60 min. The nuclear-polyhedrosis virus of the cabbage looper, *Trichoplusia ni*, the granulosis virus of the saltmarsh caterpillar, *Estigmene acrea*, and the crystal (paraspore) of *B. thuringiensis* var. sotto were exposed to uv light. This variety of *B. thuringiensis* was chosen because of its extreme toxicity to the silkworm, *Bombyx mori*. The preparation of *B. thuringiensis* crystals was mixed with a sucrose solution, aliquots of which were dried and exposed to a germicidal uv lamp for 0, 7½, 15, 30, 60, or 120 min. The crystals were resuspended and fed to third-instar silkworm larvae. Both the nuclear-polyhedrosis and the granulosis viruses were prepared in a similar manner. The results indicated that 3-hr exposure to uv radiation inactivated clean unprotected polyhedrosis virus of the cabbage looper and granulosis virus of the saltmarsh caterpillar. Prolonged exposure apparently did not alter the toxicity of the parasporal body of *B. thuringiensis* var. sotto. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstract 8540.

8666 THE PROBLEM OF STERILIZATION OF PRESERVED TISSUES. **Hackenseliner, Hans-Alois (Pathologisches Institut, Berlin). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe, 16: 231-4(1967). (In German).**

The most significant sterilization procedure for tissue preservation is by γ irradiation from a ^{60}Co source or in the fuel channels of an atomic reactor, or by β irradiation. The use of α irradiation or thermal or fast neutrons may induce radioactivation of the tissue transplant. The sterilization dose used is between 1 and 4 Mrep. One disadvantage of irradiation sterilization is partial destruction of the tissue, as indicated by decreased mechanical strength. (BBB)

8667 EFFECT OF GAMMA IRRADIATION OF STRAWBERRIES AS A MEANS OF EXTENDING SHELF-LIFE AND THE LETHAL DOSE FOR BOTRYTIS CINEREA. Shibabe, Sadami; Ito, Hitosi; Iizuka, Hiroshi (Japan Atomic Energy Research Inst., Takasaki). Agr. Biol. Chem. (Tokyo), 31: 930-4(Aug. 1967).

The effectiveness of ^{60}Co γ irradiation on post-harvest decay in Donner strawberries at ordinary temperatures was tested. As a main saprophytic fungus of Donner berries, Botrytis cinerea TO-1 was isolated and identified, and its radiation sensitivity compared with that of another strain of B. cinerea (IAM 5128). From the survival (vs dose) curves of these two strains, their lethal doses were determined. The percentage infection with saprophytic fungi, such as B. cinerea, Rhizopus, and Penicillium, of strawberries kept at 21 to 23°C or at 8 to 10°C as a function of storage time (days) for various radiation doses is shown. The number of days during which no infection with fungi on berries was found was extended with increasing doses. At 21 to 23°C, one day (after harvest or irradiation) with 0 KR, 3 days with 100 KR, 4 days with 200 KR and 4 to 5 days with 300 KR. When berries were kept at 8 to 10°C, 10% infection was found on the 7th to 8th day after 0-KR irradiation, 9th to 10th day after 100 KR, 11th to 12th day after 200 KR, and 14th to 16th day after 300 KR. When berries were kept at 23°C, waterproof cellophane was effective in minimizing their weight decrease. Per cent infection with ordinary cellophane wrapping was less than that for waterproof cellophane wrapping at this temperature. Lethal doses for TO-1 and that for IAM 5128 strains of B. cinerea were found to be 970 and 540 KR, respectively. The isolated strain TO-1 was more resistant to radiation than IAM 5128. The value, 970 KR, that was found to be the lethal dose for the isolated strain of B. cinerea was larger than either the lethal dose for Penicillium or for Aspergillus, both of which were found, under the same experimental condition, to be 200 to 250 and 400 KR, respectively. (BBB)

8668 POSSIBLE APPLICATIONS TO FOOD OF IONIZING AND NONIONIZING RADIATIONS. Goldblith, Samuel A. (Massachusetts Inst. of Tech., Cambridge). J. Amer. Dietet. Ass., 51: 233-7(Sept. 1967).

Development of processes utilizing ionizing and microwave irradiation for food preservation is reviewed. In programs investigating the use of ionizing radiation, the foods of greatest interest are: fish, e.g., haddock, cod, flounder fillets; shellfish, e.g., shucked clams, oysters, cooked shrimp, crabmeat, lobster; vegetables and fruits, e.g., tomatoes, strawberries, bananas, papayas; poultry and eggs; and grains and potatoes. Studies with these foods are described. With relatively low doses of ionizing energy it is now possible to provide seafoods at refrigerator temperatures above freezing in the interior portions of the country and to provide for increased storage life for these products in the seashore areas, thus enabling better economics because of increased shelf-life in the refrigerator. Radiation preservation of foods at doses of 10^6 rad or less (usually less than 5×10^5 rad) and storage at 32°to 35°F is predicated on the demonstrable assumption that at these doses, the bulk of the economic spoilage organisms are destroyed and that those organisms that remain, i.e., the spore formers, will be inhibited from germination by refrigerated storage just above freezing. This method (instead of sterilization that requires doses of from 2.5 to 4.5 Mrad) is based on the fact that the undesirable side reactions (in flavor, color, texture, and odor changes) caused by sterilization doses can be reduced in many of the foods by reducing the dose. With cooked shrimp, crabmeat, and lobster, synergistic effects were found between heat and radiation, thus permitting production of better, sanitary, quality products with a longer shelf life at refrigeration temperatures above freezing. Strawberries can be treated with a dose of 150,000 rad to destroy molds, thus increasing the storage life. With bananas, radiation in relatively small doses offers a means of delaying ripening, thus increasing the banana marketing areas of the world. Radiation preservation of poultry and eggs represent an important public health potential for ionizing energy, since relatively low doses (under 5×10^5 rad) can destroy salmonellae organisms and subsequently improve the sanitation of poultry products and eggs. Relatively low doses (30,000 rad) are effective in destroying the insects that are important economic pests in grain. (BBB)

8669 GAMMA-RADIATION ACTIVITY ON IMMUNIZING, PROTECTIVE, OR SIGNIFICANT VALUES IN SOME BIOLOGICAL PRODUCTS. Chelemen, N.; Isopescu, I.; Ciortea, G.; Savulescu, M.; Cormus, D. Lucr, Inst. Cercet, Vet. Bioprep, "L. Pasteur", No. 2: 323-46(1963) (Publ. 1965). (In Rumanian).

The effects of γ radiation on liquid and freeze-dried erysipelas vaccine (VR_2 strain), erysipelas serum, brucella antigen, and purified tuberculin were determined. As a result of irradiation, some alterations in the pathogenic and sacchardytic properties of the VR_2 strain were observed; the freeze-dried germs showed a higher resistance to the liquid and freeze-dried erysipelas vaccine after irradiation. The brucella antigen exposed to doses higher than 1×10^5 R displayed an increased agglutination capacity and could not be used in agglutination reactions. Irradiation of the purified tuberculin at doses of 3.85×10^6 and 6×10^6 R did not modify its significant and organoleptic properties. As there was a marked difference between the doses that induced absolute sterilization and those that altered properties of the erysipelas serum and the purified tuberculin, it was concluded that radiosterilization was a quick and economical procedure for removal of causal germs from these products. (TSS) (Roumanian Sci. Abstr.)

8670 RADIATION PRESERVATION OF FOODS. Meeting of the American Chemical Society, Atlantic City, Sept. 16–17, 1965. Advances in Chemistry Series 65. Washington, D. C., American Chemical Society, 1967. 192p. (CONF-650902).

Separate abstracts were prepared for each of the 15 papers presented. (E.R.B.)

For abstracts of individual papers see: 8540 and 8671–8684.

8671 SOME RADIATION-INDUCED CHANGES IN FRESH FRUITS AND VEGETABLES. Massey, L. M. Jr.; Bourke, J. B. (Cornell Univ., Geneva, N. Y.). pp 1-11 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

The effects of radiation upon fresh fruits and vegetables include not only the immediate and direct influence upon chemical constitution, but also the subsequent indirect consequences of physiological and biochemical alteration. The most obvious detrimental response to irradiation is softening associated with degradation of pectin and cellulose. Some radiation-induced changes in physiology associated with storage longevity were studied. Ethylene synthesis in apples is altered by radiation. Kilorad treatment of fruit and vegetable tissue causes stimulation of respiration followed by return to near-normal rates. Investigations into the biochemical causes for this in carrots indicate little alteration of either pentose-phosphate or Embden-Meyerhof glucose metabolism. Although little effect on pyruvate decarboxylation was found, there was a marked variation in acetate metabolism. (auth)

8672 IRRADIATION FLAVOR AND THE VOLATILE COMPONENTS OF BEEF. Wick, Emily L.; Murray, Edwina; Mizutani, Junya; Koshika, Mitsuo (Massachusetts Inst. of Tech., Cambridge, Mass.). pp 12-25 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

Knowledge of the volatile components of irradiated and nonirradiated beef is reviewed. Concurent and nonconcurrent irradiation procedures produce the same compounds but in different relative quantities. Storage of irradiated beef decreases irradiation flavor and the quantity of volatile constituents. Methional, 1-nonanal, and phenylacetaldehyde are of primary importance in beef irradiation off-flavor produced under the conditions described. (auth)

8673 VOLATILE COMPOUNDS INDUCED BY IRRADIATION IN BASIC FOOD SUBSTANCES. Merritt, Charles Jr.; Angelini, Pio; McAdoo, D. J. (Army Natick Labs., Mass.). pp 26-34 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

Irradiation flavor and odor in meat are believed to be caused by the volatile chemical compounds produced by radiation impact on the protein and lipid molecules. The volatiles from irradiated ground beef, pork, mutton, lamb, and veal as well as the volatile irradiation degradation products of several amino acids and proteins, animal fats, methyl esters of fatty acids, and triglycerides, were analyzed by programmed cryogenic temperature gas chromatography to separate the complex mixtures obtained and rapid scanning mass spectrometry to identify the individually separated components. The results are compared with those obtained from irradiating meat itself and separate meat fractions, thus establishing the contribution of each fraction to the total. Mechanisms are postulated for the formation of the volatile components from each fraction. (auth)

8674 EFFECT OF IRRADIATION TEMPERATURE AND PROCESSING CONDITIONS ON ORGANOLEPTIC PROPERTIES OF BEEF AND CHEMICAL YIELDS IN MODEL SYSTEMS. Harlan, Jerry W. (Swift and Co., Chicago); Kauffman, Leo; Heiligman, Fred. pp 35-57 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

The irradiation flavor intensity of enzyme-inactivated beefsteaks decreases linearly with irradiation temperature in the range +20° to −196°C. The rate of decrease varies with the irradiation dose. A large temperature effect on the yields of primary radiochemical reactions of amino acids and peptides in aqueous solutions was found in chemical studies conducted in our laboratory. A process variable study on enzyme-inactivated steaks showed that an organoleptically superior radiation-sterilized steak can be produced by irradiating at liquid nitrogen temperatures in vacuum and slowly warming to room temperature for storage. (auth)

8675 RADIATION CHEMISTRY OF POLYAMINO ACIDS IN AQUEOUS SOLUTIONS. Southern, E. M.; Rhodes, D. N. (Low Temperature Research Station, Cambridge, Eng.). pp 58-77 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

The radiation chemistry of compounds related to the proteins (amino acids and peptides) is reviewed briefly. Experiments with aqueous solutions of polyamino acids showed that a major effect of radiation was cleavage of the peptide linkages with formation of amide and carbonyl groups. Yields of amide were increased in oxygen. Inversion of L-glutamate residues to D-glutamate and exchange of carbon–bound hydrogen atoms for tritons in the solvent were observed in poly-α,L-glutamic acid. Several new amino acid residues were detected in irradiated poly-α,L-glutamic acid, poly-D,L-alanine, and poly-L-proline. The pH of the solution during irradiation affects the physical and chemical changes induced in the polyamino acids. (auth)

8676 ELEMENTS OF GAMMA IRRADIATOR DESIGN. Manowitz, Bernard (Brookhaven National Lab., Upton, N. Y.). pp 109-17 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

Irradiation devices for destroying bacteria in packaged goods consist of a radioactive source, a conveyor, and shielding. For food irradiation the important design criteria include a high uniformity of treatment, relatively short irradiation times, and close temperature control. Three steps in making a ^{60}Co source are encapsulation of the cobalt, irradiation in a nuclear reactor, and secondary encapsulation along with appropriate testing and radiation assay. Advantages of high specific activity ^{60}Co—the number of encapsulations are reduced and the volume of the irradiator to be shielded is minimized—must be balanced against the cost of obtaining higher specific activities. For food pasteurization irradiators, design techniques are available today. For food sterilization applications considerably more design and source technology development are needed. (auth)

8677 RADIOACTIVITY CRITERIA FOR RADIATION PROCESSING OF FOODS. Koch, H. W.; Eisenhower, E. H. (National Bureau of Standards, Washington, D. C.). pp 87-108 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF–650902.

The high-dose-level processing of foods with high energy electrons and x rays can induce measurable radioactivity. Such radioactivity might, but fortunately need not, present a food wholesomeness problem. The amount of induced radioactivity can be controlled and limited so as to be nonmeasurable by limiting the maximum energy of the radiation to 10 MeV. Therefore, nonmeasurability is one useful criterion. Another criterion may be developed from considerations of maximum permissible concentrations of radioisotopes in foods and of the deliberate or chance nature of the occurrence of the activity. The bases of these criteria and of possible future developments are detailed by considering characteristics of photonuclear reactions, detection methods and capabilities, influences of production parameters, and maximum permissible concentrations. (auth)

8678 ESTABLISHING A FOOD IRRADIATION FACILITY, AND RELATED ECONOMIC ASPECTS. Dietz, George R. (Atomic Energy Commission, Washington, D. C.). pp 118-25 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

The approach to selecting a radiation-processing facility parallels that for conventional or nonradiation plants. The determination and analyses of facility requirements for radiation-processed foods require knowledge of the conventional processing counterpart. In most cases, the irradiation must be made an integral part of the process and not merely an extra step plugged into an existing facility or process. The combination and relative importance of present or proposed product-handling techniques, together with the normal technological response patterns of foods involved, will dictate site location, facility size, through-put rates, and ultimate economics. The relation of these production requirements is explored, with reference to facilities for pasteurization and sterilization of food products. (auth)

8679 SHALLOW IRRADIATION OF ORANGES BY ELECTRONS. A FEASIBILITY STUDY FOR IN-LINE PROCESSING. Benn, Thomas R. pp 126-38 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

Experimental data developed to bridge the gap between research and the commercial application of irradiation energy are reviewed. For convenience these studies were performed with oranges, but the techniques apply to all fruits and indeed spherical shapes where only shallow penetration by electrons is required. The work was designed to generate and present data in a manner that will be meaningful to processers who generally are not expert in irradiation technology. The work was continued to a point where in-line processing could be contemplated. Domestic commercial situations for fruit do not support the construction of a pilot plant at this time. (auth)

8680 ^{137}Cs AVAILABILITY AND POTENTIAL MARKET. O'Sullivan, E. T. (Isochem, Inc., Richland, Wash.). pp 139-41 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

The fission product and encapsulation plant (FPCE) to be built by Isochem, Inc., in Washington state will produce fully encapsulated fission products for the commercial market. Among these, all of which are extractable from Hanford's plutonium process residues, is ^{137}Cs, a 600-kv gamma emitter of interest to the process irradiation industry. Isochem will offer cesium in large production quantities and low cost to irradiators of foods, woods, chemicals, etc. Its 30-year half-life promises economies in source array replenishment to compensate for decay. Cesium thus becomes an economic contender for current and planned irradiation applications. (auth)

8681 FRUIT AND DRY PRODUCT IRRADIATION PROCESSES. Dennison, R. A. (Univ. of Florida, Gainesville). pp 152-5 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

The tolerance limitation of fruit for irradiation establishes the maximum acceptable dose. If this dose controls decay organisms, the use of irradiation for a particular fruit may appear promising Response to irradiation may be influenced by fruit maturity, variety pre- and postharvest temperatures, handling, and extent of fungus growth. Climacteric fruits irradiated prior to the normal rapid increase in respiration usually show an immediate increase in respiration and the production of ethylene. These fruits are frequently retarded in ripening. (auth)

8682 RADIATION PASTEURIZATION OF FISH AND SHELLFISH. Novak, Arthur F.; Grodner, Robert M.; Rao, M. R. Ramachandra (Louisiana State University, Baton Rouge). pp 142-51 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

Irradiation is a practical means of preserving fish and shellfish and is sound from the standpoint of food stability and economy. With practical application comes the responsibility for protecting the consumer and producer by adequate quality control measures, that will vary with the type of fish or shellfish and its major components. Perhaps the most important quality control measure that can be used is the selection of wholesome products prior to irradiation. Irradiation will not improve the quality of poor food, but it will retain the attributes of good food. (auth)

8683 U. S. ARMY RADIATION LABORATORY. Jarrett, Robert D. Sr. (Army Natick Labs., Mass.). pp 156-70 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

The world's largest irradiation laboratory for preserving foods by ionizing energy is operated by the U.S. Army at Natick, Mass. It has two radiation sources, a food development-preparation laboratory, and an experimental development kitchen. The sources are ^{60}Co and an electron accelerator with a maximum energy of 24 MeV. They are supported by three laboratories: health physics, radiochemistry, and dosimetry. Other facilities include a section that develops suitable containers for use in irradiation experiments. By housing all these facilities in one location, one has complete control over each phase of the experimental procedure. The Army is concentrating its efforts on meat sterilization to provide the armed services with food that needs no refrigeration and yet resembles fresh food when prepared. (auth)

8684 AMINO ACID DESTRUCTION IN BEEF BY HIGH ENERGY ELECTRON BEAM IRRADIATION. Johnson, Connor; Moser, Karen (Univ. of Illinois, Urbana). pp 171-9 of Radiation Preservation of Foods. Washington, D. C., American Chemical Society, 1967.

From American Chemical Society, 150th National Meeting, Atlantic City, Sept. 16–17, 1965. See CONF-650902.

When ground beef is irradiated by electron beam and γ irradiation and its proteins assayed for amino acid content, the most sensitive amino acid to irradiation by either source is cystine. Approximately 50% of cystine is destroyed under the most damaging conditions used. Under the same conditions tryptophan shows about 10% destruction while arginine, phenylalanine, and tyrosine showed no destruction, and the rest of the amino acids show little destruction. From the cystine and tryptophan data, it appears that for electron beam irradiation the extent of destruction is not related primarily to total dose but to dose rate and particularly to energy level of irradiating dose. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 9461.

8685 (ORNL-4170) METALS AND CERAMICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1967. Peterson, Sigfred (comp. and ed.) (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 273p. Dep. CFSTI.

The report is divided into 40 sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 8255, 8686–8688, 8695, 8696, 8704–8707, 8727–8746, 8765, 8766, 8788, 8806, 8820–8823, 8840, and 10060.

8686 (ORNL-4170, pp 108-14) FUEL ELEMENT FABRICATION DEVELOPMENT. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

The successful operation of a flame reactor technique for the direct conversion of UF_6 to uranium oxide powder was demonstrated. Other investigations in chemical vapor deposition include deposition of UO_2 from uranium chlorides and lithium reduction of UF_6 to produce uranium nitrides or carbides. Non-fuel-bearing compounds such as boron nitride and silicon carbide were also deposited by reactions of gaseous halides. The effects of some deposition parameters have been studied for each system. Research of reactor fuel dispersions, seeking to elucidate the differences in fabrication behavior of uranium-aluminum intermetallics and the oxide fuels, continues. The fabrication of several instrumented fuel element assemblies to be used in the startup of the Advanced Test Reactor were completed. The swelling of UAl_3-aluminum compacts during initial fabrication operations was studied. Irradiation testing of ORR fuel with a 20% increase in fuel loading was completed with satisfactory operational performance. (auth)

8687 (ORNL-4170, pp 128-37) SINTERED ALUMINUM PRODUCTS DEVELOPMENT. Martin, W. R. (Oak Ridge National Lab., Tenn.).

Sintered aluminum products (SAP) are powder-metallurgy-produced alloys that consist of aluminum oxide dispersed within an aluminum matrix. These alloys have a high strength-to-weight ratio, and this beneficial effect is stable up to temperatures approaching the melting point of aluminum. Although this alloy is attractive for applications in several reactor systems, commercial SAP materials lack the reproducibility of properties needed for many nuclear components. The problems and parameters related to primary billet fabrication of SAP for HWOCR pressure tubes and fuel rod cladding were investigated. General process steps involve feed-powder characterization, dispersion preparation, and consolidation. The parameters necessary to ball-mill suitable SAP alloys on a pilot mill scale indicate that the oxide content is reproducible within the precision of the measurement techniques. Process selection for consolidation of the milled SAP flake was completed. Two alternate methods are available, but involves careful control of a packaged billet prior to secondary working to prevent rehydration. Rehydration of SAP flake produces an unstable product that swells and blisters because of hydrogen release during elevated-temperature applications. The fracture characteristics of SAP were studied. The modes of ductile fracture were described and identified by use of a fractography technique. High-temperature fractures are initiated at single oxide particles or groups of particles. Banding and stringering of oxide particles seriously affect the fracture process. Our nondestructive testing studies have been devoted to development of techniques for the measurement of flake thickness and oxide content. (auth)

8688 (ORNL-4170, pp 142-7) ZIRCONIUM METALLURGY. Rittenhouse, P. L.; Picklesimer, M. L. (Oak Ridge National Lab., Tenn.).

The stress and strain properties of zirconium alloys in terms of crystallographic texture and the effect of fabrication variables on texture in tubing are described. Single crystal deformation studies added to our knowledge of basic deformation mechanisms and texture development and control. The orientation of the hydride in zirconium alloys has been examined with respect to texture, cooling rate, and stress cycling. Corrosion studies provided the first clear picture of the effect of crystallography on the anisotropy of oxidation in zirconium. The sensitivity of oxidation rate to impurity content was demonstrated. These studies produced a promising method for significantly improving the corrosion resistance of zirconium. (auth)

8689 (ORNL-4188) ^{90}Sr DATA SHEETS. Rimshaw, S. J.; Ketchen, E. E. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 45p. Dep. CFSTI.

Data are given on composition, specific power, radiation, critical mass, container compatibility, thermophysical properties, mechanical properties, chemical properties, biological tolerance and shielding for strontium-90 metal, titanate ($SiTiO_3$), oxide (SrO_3), fluoride (SrF_2), and orthotitanate (Sr_2TiO_4). The data are indexed to 53 references which are also included. (F.S.)

8690 (TID-21015(Rev.)) INTERPOLATED VALUES FOR THE SCHEDULE OF BASE CHARGES AND THE STANDARD TABLE OF ENRICHING SERVICES. (Oak Ridge Operations Office (AEC), Tenn. Production Div.). Dec. 1967. 245p. Dep. CFSTI.

The United States Atomic Energy Commission published in Federal Register Notice 32 FR 16289 dated November 29, 1967, a revised schedule of base charges for uranium as UF_6, to be effective January 1, 1968, and a standard table of enriching services. The schedule of base charges is applicable to uranium as UF_6 sold or leased by the AEC. The standard table of enriching services, which lists the units of feed and separative work required per unit of product, is applicable to uranium as UF_6 obtained through toll enriching contracts with the AEC. The base charges and the enriching services feed and separative work units listed in the Federal Register notice are for assay increments which vary from 0.02 to 10.00 weight percent U-235. Interpolated values to the nearest 0.01 weight percent U-235 assay using the Federal Register values as the reference values are presented as a supplement to the Federal Register. (auth)

8691 ZIRCONIUM AND HAFNIUM. Harris, W. F. (Birkenhead Tech. Coll., Eng.). Eng. Mater. Des., 10: 1919-21(Dec. 1967).

A review of Zr is given under the headings: Extraction, mechanical and physical properties, effects of irradiation, welding and brazing, machining properties, electrical machining, corrosion resistance, uses, hazards, and availability. A brief review of Hf is also included. (UK)

Corrosion and Erosion

Refer also to abstracts 8202, 8270–8272, and 8703.

8692 (COO-1319-57) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM. Quarterly Report, March 17–June 16, 1967. Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). July 10, 1967. Contract AT(11-1)-1319. 57p. Dep. CFSTI.

Additional analysis of effects of surface preparation on time-to-cracking in boiling $MgCl_2$ shows that the average time-to-breaking can be directly correlated with the potential-time behavior as measured on open circuit. Other analysis of the same data shows that the data fit log-normal distribution. Transient dissolution studies show that the breakdown of passivity by mechanically produced slip steps does not repassivate nearly as rapidly as chemically (addition of high chloride) broken passivity. Stress–strain studies of nickel single crystals showed that dissolution occurring simultaneously with flow lowers the yield point significantly compared with a flow curve determined in air. Results of thin foil examination continued to show the formation of slip step dissolution patterns in a wide variety of compositions. An extensive strain hardening study was completed and calculated values for the strain hardening parameters are reported. (auth)

8693 (DP-1102) ANALYSIS OF FAILED 17-4 PH BOLTS FROM THE HWCTR. Marshall, Robert P. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 1967. Contract AT(07-2)-1. 20p. Dep. CFSTI.

Analysis of five bolts of 17-4 PH stainless steel from the Heavy Water Components Test Reactor that had failed in service showed that the failures were initiated by stress corrosion. In all but one of the failed bolts, an unstable crack size was reached after very little stress corrosion causing fast crack propagation and complete failure. In one bolt, the stress corrosion crack had stopped growing. Many of the bolts, including all those that failed, were found to have been improperly heat treated to approximately the H925 condition, instead of the specified H1100 condition. The harder H925 condition is conducive to stress corrosion cracking in this alloy. No evidence for failure by fatigue was found. (auth)

8694 (MSAR-67-216) LIMITED COMPARISON OF THE RELATIVE MERITS OF 304 VERSUS 316 STAINLESS STEEL FOR LIQUID METAL SERVICE. Topical Report No. 10. Andrews, R. C.; Hiltz, R. H.; Kirschler, L. H.; Udavcak, R. J. (MSA Research Corp., Evans City, Pa.). Dec. 1967. Contract AT(11-1)-765. 66p. Dep. CFSTI.

A comparison is made of the relative merits of 304 versus 316 stainless steel for liquid metal service based on the limiting parameters of MSAR's AEC-sponsored material-test program and manufacturing experience. Results of metallurgical studies and mechanical property tests of material tested in air, helium, clean sodium, high-oxygen sodium, and high-carbon sodium are included. Photomicrographs, mechanical property strength, and design curves are also included as part of the comparison. The results of interviews with fabrication workers are discussed. (auth)

8695 (ORNL-4170, pp 93-6) ALKALI-METAL CORROSION OF HIGH-TEMPERATURE MATERIALS. DeVan, J. H.; Litman, A. P.; Harms, W. O. (Oak Ridge National Lab., Tenn.).

Compatibility studies using refluxing capsules, natural-circulation loops, and forced-circulation loops have brought the cumulative operating time for refractory-alloy-boiling-potassium systems to over 90,000 hr. Almost negligible dissolutive attack has occurred in either the boiler or condenser region at temperatures up to 1300°C and for times as long as 5000 hr. An engineering-scale pumped loop of the niobium alloy D-43 has operated for 2000 hr at a boiler temperature of 1200°C and a condenser temperature of 840°C. In thermal-convection loop tests of lithium in Nb−1% Zr, mass transfer of zirconium occurred from the hot- to cold-leg regions. Although small, this effect was 10 times greater at a hot-leg temperature of 1300°C than at 1200°C. Welded specimens of T-111 contaminated with 500 ppM O were attacked intergranularly in the base metal unless they had been heat treated at 1300°C after welding. Basic studies on the role of oxygen on the corrosion of refractory metals by potassium were extended to the Ta−O−K system at 600 to 800°C. Preliminary results indicate that this system behaves similarly to the Nb−O−K system; that is, oxygen is transferred from the metal to the potassium, even though the thermodynamic properties of known oxides suggest that the opposite should occur. The fast-neutron activation analysis facility for accurate and rapid determination of oxygen in alkali and refractory metals was completed after several operational difficulties were overcome. A series of refractory-metal specimens with carefully documented oxygen levels was assembled to statistically evaluate the accuracy of the system. (auth)

8696 (ORNL-4170, pp 192-205) MOLTEN-SALT REACTOR PROGRAM. McCoy, H. E. Jr.; Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

The two primary structural materials, graphite and Hastelloy N, were removed twice, after 7823 and 32,450 MWhr of operation. Mechanical property tests on the Hastelloy N from the first group indicated that the properties were equivalent to those of material given a similar neutron exposure in the ORR. The surveillance assembly was found to be damaged when it was removed the first time. Some changes were made in the design and the assembly was in good shape when removed the second time. A cast Al−5% Zn blower failed at the MSRE, throwing pieces of the alloy into the Hastelloy N tubing of the salt-to-air radiator. All of the contaminant was removed to determine the rate of penetration of aluminum into Hastelloy N. Although there was some reaction, the rate of penetration was not rapid. The radiator has since operated satisfactorily for several thousand hours. Hastelloy N suffers reductions in rupture life and ductility when exposed to a neutron flux. Small additions of titanium, zirconium, and hafnium significantly reduced the radiation damage. Hastelloy N is susceptible to weld cracking. The effects of the filler metal composition on the weldability of standard Hastelloy N were investigated. The use of an electrode coated with tungsten carbide looks very promising. Hastelloy N modified with additions of titanium and hafnium seems quite weldable, but the alloy modified with zirconium is very susceptible to weld-metal cracking. The behavior of a new coolant salt, 48NaF−3KF−49BF$_3$, in Croloy 9M and Hastelloy N was tested in thermal-convection loops. A modified fuel salt containing thorium LiF−23 mole % BeF$_2$−5 mole % ZrF$_4$−1 mole % UF$_4$−1 mole % ThF$_4$ was also being tested in loops of Hastelloy N and type 304 stainless steel. Advanced reactors will require a graphite with good dimensional stability to very high neutron doses and a very low permeability of ^{135}Xe. Several new grades of graphite were evaluated. None satisfies our requirements. Irradiation damage studies and measurements of the irradiation-creep behavior of several grades of graphite as a function of temperature up to doses of about 2×10^{20} neutrons/cm^2 have continued. The stresses that are developed as a result of non-uniform dimensional changes across a graphite tube wall at this dose level are well below the fracture stress. An integral part of the proposed molten-salt breeder reactor is a graphite-to-metal joint. Several promising brazing techniques gave sound joints that resisted attack by fluoride salts. (auth)

8697 CORROSION PROBLEMS ARISING FROM THE USE OF AUSTENITIC Cr−Ni−Fe ALLOYS IN NUCLEAR APPLICATIONS. Coriou, H.; Grall, L.; Pelras, M. (CEN de Saclay, Gif-sur-Yvette, France). Energ. Nucl. (Paris), 9: 303-13 (Aug.-Sept. 1967). (In French).

Aqueous corrosion studies carried out on Cr−Fe−Ni austenitic alloys used in the building of reactors or for irradiated fuel treatment plants is described. The media chosen include: demineralized water, water vapor, chlorinated alkaline and nitric solutions. Intergranular corrosion and stress corrosion are emphasized. (auth)

8698 POTASSIUM DROP SIZES AND TURBINE-BLADE EROSION. Lottes, Paul A. Power Reactor Technol. Reactor Fuel Process., 10: 150-1(Spring 1967).

The continued development of liquid-metal Rankine-cycle technology requires an increasing understanding of engineering problems such as the fluid mechanics of wet liquid metal vapors and subsequent turbine erosion caused by impingement of droplets. Experimental determinations of potassium-vapor-condensate droplet sizes are reported for typical thermodynamic expansion processes at 1000 to 1500°F, at 2- to 27-psia and at 0.80 to 0.95 theoretical-quality. The thermodynamic processes for seven test runs are illustrated. Erosion damage caused by the impingement of droplets on nickel-plated stainless-steel wedges, used to simulate conditions in the exhaust stages of a potassium-vapor turbine, is also described. (J.R.D.)

8699 OXIDATION CONDITIONS OF SOME INTERMETALLIC PHASES AND QUASI-BINARY ALLOYS OF URANIUM. Thuemmler, F.; Exner, H. E.; Petzow, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Nucl. Mater., 24: 328-39(Dec. 1967). (In German).

The progress of oxidation of U$_3$Si$_2$, UFe$_2$, UMn$_2$, UAl$_2$, U(Mn,Fe)$_2$, U(Mn,Al)$_2$, U(Fe,Al)$_2$, and U(Zr,Al)$_2$ in air was determined manometrically at 400 to 700°C. After an initial stage difficult to comprehend, the weight gain by oxygen was proportional to time for many systems. (U,Zr)Al$_2$ with a higher Zr content showed a nearly parabolic rate. In comparison with uranium metal, silicon-containing alloys and hot-pressed U(Fe,Al)$_2$ have bad and U(Mn,Al)$_2$ equal oxidation resistance. In the quasibinary system UFe$_2$−UMn$_2$ the oxidation velocity lying appreciably under that of uranium was not altered very much. UAl$_2$ showed an even better oxidation resistance. Low Zr additions (1.4 at. %) accelerated the oxidation, while higher Zr additions (3.4 at. % and more) retarded it very much. Homogeneous (U,Zr)Al$_2$ solid solutions with more than 10 at. % Zr were resistant in air up to 700°C. The apparent activation energy for UAl$_2$ and (U,Zr)Al$_2$ oxidation was about 22 kcal/mol. (auth)

8700 MECHANICAL STRESS OF ZIRCONIUM AND ZIRCALOY-2 BY CORROSION LAYERS. Buresch, F. E.; Bollenrath, F. (Kernforschungsanlage, Juelich, Ger.). J. Nucl. Mater., 24: 270-80(Dec. 1967). (In German).

During the oxidation of zirconium and its alloys multiaxial internal stresses exist in the metal and the oxide layer because of the high Pilling−Bedworth ratio. At temperatures above 400°C thin cylinders elongate under axial internal tensile stress and creep. Time-strain creep curves for zirconium and Zircaloy-2 are measured. At the phase boundary the pressure of the oxide growth was constant, and the multiaxial internal stresses in the metal cylinder are a function of the wall thickness. It was assumed that in thin metal cylinders the internal stresses are constant over the wall thickness and there exists a plane stress state. Analytical functions are presented and the flow stress is estimated from isochronal stress strain curves. The influence of internal stresses and deformation on the corrosion behavior of zirconium and its alloys are discussed. (auth)

8701 SYMPOSIUM ON METAL-GAS REACTIONS IN ATMOSPHERES CONTAINING CO$_2$. Brit. Corros. J., 2: 229-34(Nov. 1967).

In the last few years much work has been carried out on the oxidation of boiler and fuel cladding materials in carbon dioxide environments in the temperature range 350 to 850°C in connection with the gas-cooled nuclear reactor programme. This covers rimming, semi-killed and low alloy steels, and also 9% and 12% chromium and austenitic steels. Work has also been done in helium environments containing small amounts of CO/CO_2, relating to more advanced nuclear reactor concepts. (auth)

Preparation and Fabrication

Refer also to abstracts 8061, 8198, 8201, 8281, 8301, 10075, and 10082.

8702 (BNWL-519) NEPTUNIUM TARGET ELEMENT FABRICATION. Bloomster, C. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 18p. Dep. CFSTI.

A fabrication process was developed for preparing neptunium-alloy target elements for irradiation. Some of the target elements included high radiation level, "quick-turn-around" neptunium. (auth)

8703 (IITRI-578-P-29-17) RESEARCH ON ZIRCALOY BRAZE ALLOY DEVELOPMENT. Quarterly Report, July 1–September 30, 1967. (IIT Research Inst., Chicago, Ill.). Oct. 17, 1967. Contract AT(11-1)-578. 28p. (EURAEC-1940). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Approximately 150 braze alloy candidates have been evaluated for brazability with Zircaloy-2 and corrosion resistance to static superheated water. Twenty of these alloys have been selected for further screening in long-term hydrodynamic tests. (auth)

8704 (ORNL-4170, pp 124-7) DEVELOPMENT AND TESTING OF SOL–GEL-DERIVED $(U,Pu)O_2$ FUEL. Lotts, A. L. (Oak Ridge National Lab., Tenn).

The potential of sol-gel-derived PuO_2-UO_2 fuel for fast reactors, particularly the Liquid Metals Fast Breeder Reactor and the Fast Flux Test Facility, is being assessed. The program comprises the development of fabrication processes, out-of-reactor testing, and irradiation to high burnup in thermal reactors. The initial progress includes the development of a critical path schedule for process development, property determination, irradiation testing, and economic evaluation of the fuels as well as the preparation of suitable plutonium laboratories and equipment to accomplish the work. A non-instrumented capsule for irradiation of the fuels in the Engineering Test Reactor was designed, and irradiation of the first capsules commenced. In addition, work was initiated on the low-energy compaction of sol-gel microspheres, extrusion of sol-gel clays, and the pelletizing of sol-gel powder. No definitive results have yet been obtained from the program. (auth)

8705 (ORNL-4170, pp 138-41) WELDABILITY OF HIGH ALLOYS. Slaughter, G. M. (Oak Ridge National Lab., Tenn.).

Cracking behavior and mechanical properties of welds in nickel- and iron-base alloys are investigated. A large number of special alloys of the Inconel 600 (Ni – 15.5% Cr – 8.0% Fe) and Incoloy 800 (Fe – 32.5% Ni – 21.0% Cr) types were processed. Excellent control over the melting and fabrication parameters led to a very-high-purity product. The VARESTRAINT test developed was used to evaluate the crack susceptibility of welds in three commercial alloys. The total crack length at 2% augmented strain was approximately 500 mils for Inconel 600 and 1100 mils for Incoloy 800 and Hastelloy X. Thus the Inconel 600 appears to resist hot cracking somewhat better than either of the two other materials. The effect of heat input on the properties of welds in austenitic stainless steel was also studied. The intercellular spacing of the weld metal increased with increasing heat input and the delta ferrite distribution varied markedly. Welds made at 10,000 J/in. had 10,000-psi greater tensile strength at room temperature than those made at 60,000 J/in. The ductility of the weld metal appears to increase with the amount of delta ferrite in the microstructure in the range observed. (auth)

8706 (ORNL-4170, pp 173-83) HIGH FLUX ISOTOPE REACTOR. Adamson, G. M. Jr. (Oak Ridge National Lab., Tenn.).

The quality of the HFIR fuel-element development work has been attested by in-reactor performance. Thirteen assemblies have been burned to an average burnup of 2300 MWd with no obvious problems. Fuel-element production is proceeding smoothly through completion of the first commercial procurement contract and the starting of a second. Fuel-plate recoveries of 92% have been achieved, with blisters and surface defects being the major causes for rejection. Waivers of acceptance standards, however, have been required on most elements; deviations vary in cause from one unit to another. Data obtained from the fuel fabricator were analyzed to demonstrate what effects changes in the specifications would have on rejection rates. Several areas were found in which specifications could be tightened without economic penalty, while relaxation is desirable in others. Fuel plates of HFIR geometry but with a 25% increase in fuel loading were fabricated with both U_3O_8 and UAl_3 used as the fuel. The amount of densification during hot rolling differed, with the intermetallic being less dense. New cleaning and rolling procedures were developed to eliminate the need for type 1100 bonding layers on the frame. Previously such layers were required to achieve adequate bonding between frame and cover plates. Pulsed-arc and electron-beam welding are being investigated as alternate techniques for joining fuel plates during final assembly. The former method did not show sufficient advantage to warrant necessary changes in procedure and equipment. The latter method, however, shows promise of simpler and more closely controlled welding practice, if a suitable side plate material with less tendency for weld cracking than type 6061 can be found. Longitudinal spacers were ultrasonically welded to plates, which were then curved to the required involute. After being assembled in a test rig, such plates successfully resisted abrasion and flow stresses. (auth)

8707 (ORNL-4170, pp 229-32) ISOTOPIC POWER SOURCE DEVELOPMENT. Beaver, R. J.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.).

The development of procedures for gas tungsten-arc welding of heavy-walled refractory-alloy (TZM) capsules was undertaken in an effort to produce full-penetration welds for containers of alpha-emitting isotopes. The techniques developed were shown to be feasible and acceptable by metallographic examination and helium leak testing of demonstration capsules. A second developmental welding program was aimed at sealing of the Hastelloy C capsule for SNAP-21. Gas tungsten-arc welding did not consistently produce welds of sufficient penetration and still permit ultrasonic inspection. These difficulties were overcome by the use of electron-beam welding. Equipment suitable for electron-beam welding in hot cells is being assembled. Fluorescent penetrant and ultrasonic inspection techniques were evaluated for the inspection of capsule components, raw material, and welds in fueled capsules. A material and design study was made in support of a Brayton cycle system with a radioisotope heat source. Recommendations were made for the stress-bearing encapsulating material as well as materials for a diffusion barrier, oxidation protection, and a high emissivity coating. (auth)

8708 (ORNL-4190) FABRICATION OF INSTRUMENTED FUEL ELEMENTS AND IN-PILE CAPSULES. Franco-Ferreira, E. A.; Williams, L. C. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 33p. Dep. CFSTI.

Techniques used at ORNL for fabricating and installing instrumented fuel elements and in-pile capsules are described. These techniques are specialized adaptations of welding and brazing which introduce the fewest extraneous variables into tests for evaluating the design, the fuel, and cladding materials of reactor fuel assemblies. The bulk of capsule instrumentation is in the form of thermocouples for measuring the temperature of the cladding and of the center of the fuel. Cladding temperature thermocouples were joined to the inside surface of the cladding by special brazing techniques. Fuel central temperature is measured by refractory- or noble-metal thermocouples contained in refractory-metal wells which pass through holes in the center of the fuel pellets. The thermocouple wells must be reliably sealed to stainless steel or other alloy end caps to prevent fission gas release. Methods of making transition joints for these dissimilar combinations were developed. Unique designs were also developed for making welded tungsten versus rhenium thermocouple junctions which would be resistant to failure due to thermal cycling. Methods used for making instrumented in-pile capsules were adapted to the production of five instrumented fuel assemblies for the Experimental Gas-Cooled Reactor at Oak Ridge. These fuel assemblies were intended to be the only in-core instrumentation in the reactor, and all reactor operation would be dependent on their functioning properly. Special, high-melting-point, refractory-metal-base brazing alloys were used in building refractory-metal in-pile capsules. The adaptation of electron beam brazing to their manufacture is also described. (L.C.L.)

8709 (ORNL-TM-2066) THE STATISTICAL DESIGN AND ANALYSIS OF CHEMICAL VAPOR DEPOSITION EXPERIMENTS. Patterson, F. H.; Robinson, W. C. Jr.; Hebble, T. L. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 49p. Dep. CFSTI.

The effect of the controllable experimental variables on total weight of deposited grams of metal deposition, deposition efficiency, and deposition thickness uniformity was investigated for the chemical vapor deposition of tungsten. Independent experimental variables include temperature, pressure, total inlet-gas flow rate, and mole percent WF_6 in inlet-gas stream for the constant-time runs. A statistical experimental design was used that allowed the estimation of parameters in a third-order polynomial relating the responses to the independent experimental variables. Eightyone experiments were required. The design, experimental results, and resulting correlations are given. (auth)

8710 (WCAP-3791-9) VANADIUM CLADDING ALLOY DEVELOPMENT. Quarterly Progress Report for the Period Ending September 30, 1967. Bishop, E. C.; Nadler, R. A.; Whitlow, G. A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Oct. 1967. Contract AT(30-1)-3791. 62p. Dep. CFSTI.

A program to develop and characterize the properties of V-based alloys which are superior to stainless steel for fuel cladding in the LMFBR is described. The alloy must have strength to contain the fuel at 800°C, be resistant to liquid Na corrosion, be compatible with mixed Pu-U ceramic fuel, be resistant to embrittlement by fast flux irradiation, and be readily fabricated into high quality tubing. After the work program was approved, plans and controls were established. A cost comparison of V alloy cladding versus stainless steel cladding was started. The initial quantity of V granules and alloying materials were procured and analyzed, and melting of alloy ingots was begun. Two V test-loops were designed and construction started, and planning for sodium evaluations was started. Fuel capability tests and design of the test capsule were started. Planning of the post-irradiation evaluation and design of irradiated specimens and capsules was also started. (F.S.)

8711 PREPARATION AND PROPERTIES OF UA1$_x$ COATINGS FORMED ON URANIUM VIA THE ELECTROPHORETIC DEPOSITION OF ALUMINIUM POWDER. Pearce, R. J. (Central Electricity Generating Board, Berkeley, Eng.); Giles, R. D.; Tavender, L. E. J. Nucl. Mater., 24: 129-40(1967).

A method is described of preparing UAl$_x$ coatings on uranium by electrophoretic deposition of aluminum powder followed by heating in vacuum. The optimum conditions have been shown to be deposition of a fine aluminum powder onto a freshly electropolished uranium surface followed immediately by heat treatment for 20 hr at 650°C. The structure of a coating formed in this way has been shown to consist of a primary UAl$_3$ phase containing UAl$_2$ at uranium—coating interfaces. UAl$_4$ was also identified as a fine black powder on the coating surface. Oxidation in flowing carbon dioxide has established that such coatings can give a limited oxidation protection to uranium, delaying the onset of the rapid oxidation that occurs with uncoated uranium for ~100 hr at 450°C or ~25 hr at 550°C. (auth)

8712 ELECTRON-BEAM WELDING OF BERYLLIUM. Hauser, D.; Mishler, H. W.; Monroe, R. E.; Martin, D. C. (Battelle Memorial Inst., Columbus, Ohio). Weld. J. (N. Y.), 46: 525s-40s(Dec. 1967).

Electron-beam welding procedures were investigated for four thicknesses of beryllium sheet: $^1/_8$, $^1/_{16}$, $^1/_8$, and $^1/_4$ in. Principal factors examined for their influence on weld quality included beam voltage, beam current, beam diameter, travel speed, preheat temperature, surface preparation, beryllium-sheet composition, and joint restraint. For the three thicker sheets, weld undercutting and surface roughness were major obstacles in the development of satisfactory welding procedures. Techniques that alleviated or entirely eliminated these problems were: welding with low travel speeds, welding with low-power-density electron beams, use of multiple-pass welding techniques, use of sheet containing a low beryllium oxide content, and use of beryllium shim material preplaced in the joint to provide filler metal. Films observed on weld surfaces were found to contain a large percentage of beryllium oxide. The thickness of these oxide films increased with the oxide content of the base metal. Weld undercutting, surface roughness, and porosity were also observed to increase with the beryllium oxide content of the base metal. For the same sheet thickness and welding conditions, the quality of welds in low-oxide sheet (containing 0.69% BeO) was significantly better than in high-oxide sheet (containing 1.93% BeO). The effects of restraint on weld cracking were evaluated by determining the preheat temperature necessary to prevent cracking when high and low restraints were imposed on butted sheets. Higher preheat temperatures were necessary when the restraint was increased. Bend tests and tensile tests were performed with base metal and welded specimens that were $^1/_{16}$ and $^1/_8$ in. thick. Bend transition temperatures from ductile to brittle behavior were about twice as large for transverse-bend specimens as for base metal specimens. Greater bend ductility was exhibited by specimens having lower amounts of beryllium oxide. Welded specimens displayed lower strengths and less ductility than did unwelded specimens. Longitudinal-welded specimens were significantly more ductile than transverse-welded specimens. (auth)

8713 JOINING BERYLLIUM BY AN ELECTRON-BEAM BRAZE WELDING TECHNIQUE. Hicken, G. K.; Sample, W. B. Jr. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Weld. J. (N. Y.), 46: 541s-50s(Dec. 1967).

An investigation was undertaken to determine the feasibility of braze welding beryllium by using an electron-beam technique. An aluminum shim was preplaced at the interface between pieces of beryllium to be joined, and the resulting "sandwich" was then electron-beam welded in the usual way. Shims, varying in thickness from 0.004 to 0.018 in., of aluminum alloys 1100, 2024, 5052, 5083, 6061, and 718 were used. Braze welds were made on hot-pressed powder material in thicknesses of 0.177 and 0.250 in. and in vacuum cast, hot-rolled beryllium, in thicknesses from 0.025 to 0.500 in. Full penetration welds, free of cracks, porosity, and undercutting can be made in vacuum cast, hot-rolled beryllium using the electron-beam braze welding technique. Hot-pressed material can be joined, but porosity levels are high and cannot readily be reduced. Tensile strengths of welds made in the vacuum cast, hot-rolled material exceeded the strength of the base metal. Values as high as 46,000 psi were achieved. Weld tensile strength did not vary significantly with the composition of the filler metal, except that alloy 2024 did produce lower than average strength joints. Dilution of the beryllium fusion zone with aluminum tended to produce a finely branched dendritic structure, and addition of up to 35 wt % aluminum enhanced the fracture toughness and tensile strength of the weld. (auth)

8714 FABRICATION OF UNALLOYED PLUTONIUM AND PLUTONIUM BASE ALLOYS. Wick, O. J. (Battelle Memorial Inst., Richland, Wash.). pp 585-98 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Melting and casting, machining, and mechanical working methods are described for fabrication of unalloyed Pu and Pu-base alloys. Unalloyed plutonium refers to material with a nominal purity of 99.8 wt % or better. Fabrication methods used on Pu are often determined by the specialized facilities at hand and are generally batch-type operations applied to a few kilograms at a time because of critical mass limitations. Unalloyed Pu is usually fabricated by casting and machining because of the brittle nature of the alpha phase, the stable form at ordinary temperatures. It can be fabricated at beta phase and higher temperatures by rolling, extrusion, or forging. (P.C.H.)

8715 PLUTONIUM METALLIC FUELS. Wick, O. J. (Battelle Memorial Inst., Richland, Wash.). pp 599-617 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Fabrication is described for Al-base—Pu, Pu-base—Al, and Pu-base—Fe alloys for use as nuclear fuels. Al-base—Pu alloys have been used on a large scale in thermal reactors, as in the plutonium loading for the MTR, the spike enrichment of the PRTR, and the transplutonium fuel elements. Metallic Pu stabilized in the delta phase by alloying with Al or Ga has been used as a fast reactor fuel in the LASL reactor Clementine and ANL's EBR-I. Pu—Fe eutectic alloy was selected for Core I and Core II of the LAMPRE because of its low melting point and lesser corrosive attack on Ta. (P.C.H.)

8716 IMPROVEMENTS IN OR RELATING TO THE EXTRUSION OF COMPOSITE BODIES. Ormerod, Leslie Roy (to United Kingdom Atomic Energy Authority). British Patent 1,096,303. Dec. 29, 1967. Filed May 25, 1964.

The extrusion of composite bodies such as fuel elements is described. When one of the components of the body is Al the Al is anodized by a chromic acid process. The slug has an outer and inner Al sleeve and a sleeve of a nuclear fuel alloy interposed between the Al sleeves. (F.S.)

8717 HOT DIP GALVANIZING. Edited Proceedings of the 7th International Conference, Paris, June 1964. Hughes, A. T. (ed.). New York, Pergamon Press, 1967. 530p. $25.00. (CONF-640634). DTIE.

The 33 papers presented are grouped in 12 chapters along with discussions. Topics covered include: plant design and layout, handling equipment, surface preparation, fluxes, tube and wire galvanizing, metallurgy of the galvanizing process, thickness measurement and other coating tests, welding, atmospheric exposure of painted galvanized steel, zinc anodizing, performance and application of galvanizing steel, and zinc anodes in tanks. (M.C.G.)

8718 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Noden, Joseph Desmond (to Central Electricity Generating Board). British Patent 1,095,273. Dec. 13, 1967. Filed May 24, 1965.

An improved method is described for preparing uranium based fuel in finned cans. The inner portion of the can is ductile Magnox

AL 80 or Magnox ZR 55 and the fins and exterior are formed of a creep resistant material such as Magnox ZR 57, Magnox MN 70, Magnox MN 150, hydrided ZR 55 or compacted powder Magnox alloy. (F.S.)

8719 METALWORKING. Byrer, T. G.; Boulger, F. W. DMIC Review of Recent Developments, May 26, 1967. Columbus, Ohio, Battelle Memorial Inst., 1967. 4p.

A survey of metalworking includes investigations to evaluate candidate materials to be used as forging lubricants and studies in the development of cemented carbide tool materials. A research program has demonstrated that lubricants other than heavy-duty cutting fluids, usually composed of S, Cl or P compounds, can be developed from considerations of surface chemistry. Experiments show that the use of iodine-charge-transfer complexes as additives to hydrocarbon oils produced improvement in lubricating ability for Ti-to-Ti and Ti-to-steel sliding surfaces. Cemented carbide tools with refractory metal binders exhibiting exceptional cutting capabilities on 4340 steel contain a NiCr or CoMo refractory matrix in combination with WC–TiC solid solutions plus additions of TaC. The development of extrusion die materials and a pneumatic extrusion system utilizing an inert gas under pressure are described. Process parameters for the extrusion of thin-section steel shapes are given and problems encountered in the forging of Be are reviewed. 10 ref. (Rev. Met. Lit.)

8720 URANIUM ALLOYS. (to Comitato Nazionale per l'Energia Nucleare). British Patent 1,097,904. Jan. 3, 1968. Priority date Jan. 29, 1965, Italy.

A method for producing alloys of Nb–Mo–U, and Mo–U–Zr is described. The alloys have fine grain structure after casting. The grain structure is refined by using a heat treatment which includes heating the alloy in the γ-phase at 900°C and cooling at the rate of 5 to 60°C per min. (F.S.)

8721 IMPROVEMENTS IN OR RELATING TO TUBES. Davies, Jared Marshall; Steer, Colin (to United Kingdom Atomic Energy Authority). British Patent 1,097,571. Jan. 3, 1968. Filed Mar. 1, 1965.

A method is described for homogenizing the structure of butt welded tubes. The tubes are suitable for use in nuclear energy applications. The method consists of reducing the wall thickness of the tube by planetary swaging and subsequently heat treating the tube material to effect recrystallization. (F.S.)

Properties Evaluations

Refer also to abstracts 8040, 8324, 8710, 8767, 8826, 10159, and 10162.

8722 (BM-RI-7063) VAPOR PRESSURES OF LIQUID MOLYBDENUM (2,890^0 TO 2,990^0 K) AND LIQUID ZIRCONIUM (2,229^0 TO 2,795^0 K). Koch, R. K.; Anable, W. E. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Jan. 1968. 22p. Dep. CFSTI.

The vapor pressures of liquid molybdenum and liquid zirconium were determined by the Langmuir free-evaporation method. An electron-beam furnace with a water-cooled copper crucible was used for melting. Temperature was measured with a two-color ratio pyrometer. The vapor-pressure data led to the following equations: $\log p\ (\text{atm}) = 5.429 - 28{,}380/T$ for liquid molybdenum in the range 2,890 to 2,990°K, and $\log p\ (\text{atm}) = 6.521 - 30{,}940/T$ for liquid zirconium in the range 2,229 to 2,795°K. Third-law evaluations of each data set gave mean heats of sublimation (298.15°K) of 157.6 ± 1.8 kcal/mole for molybdenum and zirconium, respectively, where the uncertainties are two standard deviations. Second-law standard heats of sublimation determined from sigma plots and tabulated enthalpies were 143.5 ± 2.7 and 149.2 ± 3.8 kcal/mole for molybdenum and zirconium, respectively. The better agreement in heats of sublimation for zirconium is attributed to the 566°K temperature range studied, which permitted a more accurate definition of the vapor pressure curve than could be obtained from the 100°K span for molybdenum. This supposition was verified by making a sigma-prime plot that utilized solid vapor pressure data for molybdenum to extend the evaluation range by 800°K. This gave a standard heat of sublimation of 155.2 ± 1.6 kcal/mole, which is in good agreement with the third-law value. The plot also gave a standard entropy of sublimation (298.15°K) of 35.73 ± 0.48 eu. (auth)

8723 (GEMP–570) HIGH-TEMPERATURE CREEP-RUPTURE BEHAVIOR OF SOME TUNGSTEN–RHENIUM–MOLYBDENUM ALLOYS. Flagella, P. N.; Tarr, C. O. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Dec. 6, 1967. Contract AT(40-1)-2847. 24p. Dep. CFSTI.

Thirty-four compositions of tungsten–rhenium–molybdenum alloys, fabricated by powder metallurgy techniques, were evaluated for fabricability, strength, and ductility to assess their potential for use in high-temperature nuclear reactor components. Compositions in at. % ranged from 15 to 75 W, 0 to 65 Mo, and 15 to 30 Re and involved both solid-solution and two-phase alloys containing varying amounts of the rhenium-rich sigma phase. After sintering, most of the alloys presented no problems in working to 0.02-in.-thick sheet by hot-rolling 80% followed by cold-rolling 50%. Each alloy was constant-load, creep-rupture tested at 1600 and 2200°C in H. At 1600°C, the alloys containing 10, 20, and 30 at. % Mo exhibited a transition in the ductility and creep resistance in the region of 23 to 25% Re. Apparently, this was related to the effect of the phase boundary in this region at 1600°C. A more pronounced effect of the phase boundary on the ductility was observed at 2200°C for the same alloys; the ductility rose on either side of the boundary. At 2200°C, a transition in the creep resistance occurred at the phase boundary with the solid-solution alloys being significantly stronger. Alloys containing 30 at. % W, when tested at both 1600 and 2200°C, displayed a decrease in creep resistance with increasing amounts of Re (and decreasing amounts of Mo). The ductility was insensitive to composition at 1600°C but increased with increasing Re content at 2200°C. Rupture for all the alloys evaluated at both 1600 and 2200°C appeared to be intergranular. Numerous voids were formed within the grain boundaries, transverse to the stress direction; these appeared to coalesce as strain progressed causing fracture. (auth)

8724 (MLM-1441) ^{238}Pu AND ^{210}Po DATA SHEETS. (Mound Lab., Miamisburg, Ohio). Sept. 29, 1967. Contract AT(33-1)-Gen-53. 91p. Dep. CFSTI.

A compilation of data available as of October 1967, for the fuel forms ^{238}Pu and ^{210}Po is presented. Properties of plutonium metal, PuO_2 microspheres, PuO_2, PuC, PuN, Pu-20 at. % Zr alloy, Pu-10 at. % Zr alloys, polonium metal, gadolinium polonide, and gadolinium polonide in a Ta matrix are given. (M.C.G.)

8725 (MSAR–67-207) EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Quarterly Progress Report, July–September 1967. Andrews, R. C.; Barker, K. R. (MSA Research Corp., Evans City, Pa.). Nov. 1967. Contract AT(11-1)-765. 24p. (XAC–720264). Dep. CFSTI.

STAINLESS STEEL—mechanical properties of types 304 and 316, effects of high temperature sodium on
SODIUM—effects on mechanical properties of chromium–molybdenum alloys and stainless steels at high temperatures
CROLOY—mechanical properties of, effects of high temperature sodium on
CHROMIUM ALLOYS—Cr–Mo, effects of high temperature sodium on mechanical properties of
MOLYBDENUM ALLOYS—Cr–Mo, effects of high temperature sodium on mechanical properties of
REACTORS, FAST; REACTORS, BREEDER; REACTORS, LIQUID METAL COOLED—materials for, effects of high temperature sodium on
OXYGEN—effects on plugging in liquid sodium loops
CARBON—effects of, as impurity in liquid sodium reactor coolant
SODIUM—analysis of liquid, for impurities, surface tension method for (D.E.B.)

8726 (NAA-SR–12601) HELIUM EMBRITTLEMENT IN TYPE 304 STAINLESS STEEL. Kramer, D.; Brager, H. R.; Rhodes, C. G.; Pard, A. G. (Atomics International, Canoga Park, Calif.). Dec. 5, 1967. Contract AT(04-3)-701. 31p. Dep. CFSTI.

Helium was uniformly injected into small tensile samples of Type 304 stainless steel to concentrations of 1×10^{-7} and 3×10^{-6} atom fraction helium. Subsequent tensile testing above 1000°F revealed progressive ductility loss—as measured by total elongation at rupture—with increasing temperature. This effect was more severe in samples with the high helium content where elongations at 1400°F were a third or less of those of control samples. Yield and tensile strengths remained unaltered by the presence of helium. Above 1200°F, grain boundary sliding, which results in intergranular cracking, becomes important. The cracks begin as voids on carbide particles which act as obstacles to grain boundary sliding. In the presence of helium, bubbles attach themselves to these carbide particles and serve as void nuclei thereby accelerating the process. Bubbles are also more prevalent on grain boundaries, dislocations, and inclusion particles than isolated in the matrix. (auth)

8727 (ORNL–4710, pp 8-11) DEFORMATION AND ANNEALING OF METALS. McHargue, C. J. (Oak Ridge National Lab., Tenn.).

Inhomogeneities in the preferred orientation of polycrystalline niobium were studied with regard to amount of deformation and position in rolled strip. The main components of the texture in the center can be described as spread from $\{111\}\langle 1\bar{2}1\rangle$ to $\{112\}\langle\bar{1}10\rangle$ at low reductions, centered on $\{112\}\langle\bar{1}10\rangle$ at intermediate reductions, and approximately $\{113\}\langle 110\rangle$ at reductions in thickness of 99.5%. At higher amounts of deformation there are further texture changes. A marked surface texture occurs at deformations of 90 to 97%. The study of effects of gold in solution and in a precipitate on recrystallization and grain-boundary mobility of zone-refined aluminum was concluded. (auth)

8728 (ORNL–4170, pp 15-18) DIFFUSION IN SOLIDS. Lundy, T. S. (Oak Ridge National Lab., Tenn.).

Self-diffusion coefficients were determined over wide temperature ranges for the body-centered cubic phase of titanium-vanadium alloys at 10% increments in composition from pure titanium to pure vanadium. Similar experiments were completed for self-diffusion in the body-centered cubic and face-centered cubic phases of manganese. The non-Gaussian penetration behavior at regions near specimen surfaces was examined for ^{58}Co and ^{60}Co in silver and ^{63}Ni and ^{60}Co in gold; efforts were made to determine the mechanisms for such a near-surface effect. Cation self-diffusion in UN and UO_2 is being studied in experiments in which material stoichiometry is closely regulated. (auth)

8729 (ORNL–4170, pp 19-26) ELECTRON MICROSCOPY. Stiegler, J. O. (Oak Ridge National Lab., Tenn.).

A fractographic technique was used to study gas bubbles and creep cavities in tungsten. Features of the crystallography and surface structures are described. The effects of temperature and stress on the nature of creep cavities and cracks are explained. A mathematical model was constructed to calculate the dynamic features of the formation of slip bands. Shear strains and shear strain rates were calculated and the stress concentration at the head of the bands was determined for different grain sizes. A graphical method is described for rapidly determining the Schmid factor or resolved shear stress on any slip plane, in any slip direction, and for any crystal system. Some modifications to equipment for preparing transmission electron microscopy specimens are described along with some techniques for the use of an electron microprobe attachment for one microscope. Some results of a study of precipitation in Hastelloy N with these techniques are presented. (auth)

8730 (ORNL–4170, pp 27-31) ELECTRONIC PROPERTIES OF METALS AND ALLOYS. Betterton, J. O. Jr. (Oak Ridge National Lab., Tenn.).

In Moessbauer studies a new method, Coulomb-recoil-implantation, was developed for study of impurities in solids and applied to ^{73}Ge in chromium. In zirconium alloys with the solutes Sc, Ti, Hf, Nb, Mo, Re, Ru, Rh, Ag, Cd, In, Sn, and Sb, measurements of low-temperature specific heat, superconductivity transition temperature, and electrical resistivity indicate a distinct separation in alloying behavior. Transition metal solutes to the right of zirconium in the periodic table appear to have localized electrons near the solutes. Transition metals in the same column with zirconium elements to the left (Sc), and B-subgroup solutes appear to show alloying effects related to the band structure. Improvements in the zone-refining apparatus for removal of oxygen impurity from zirconium permit up to 65 passes without seizure. Zirconium purity has been increased (resistivity ratio 1200 to 1300), and the high-purity material can be annealed to increase crystalline perfection without sacrifice in electrical properties. (auth)

8731 (ORNL–4170, pp 37-41) PHYSICAL PROPERTIES. McElroy, D. L. (Oak Ridge National Lab., Tenn.).

The physical property data on silicon agreed with theoretical estimates of the electronic thermal conduction, but theoretical models for lattice thermal conduction do not explain the experimental behavior in detail. Several methods to evaluate the temperature dependence of the Lorenz number revealed high-temperature deviations for platinum, tungsten, and iron. These deviations directly affect thermal conductivity prediction. Other transition metals are being measured to explore the mechanisms for this behavior. The 35% specific heat discontinuity in iron at the Curie temperature was confirmed, and an improved pulse heating calorimeter was constructed to study the iron-nickel alloys that exhibit ordering and ferromagnetism. The thermal conductivity of beds of vibratorily compacted ThO_2 microspheres was shown to be temperature insensitive but quite sensitive to gas and gas pressure. Comparative longitudinal apparatus was used to provide data on a variety of oxides including MgO, ThO_2, $(Th,U)O_2$, BeO, Tm_2O_3, and UO_2. Absolute longitudinal apparatus was used to generate data for critical evaluation on Al, Fe, Pt, In, W, and Cu in the little studied region, 77 to 400°K. The applicability of the ultrahigh-vacuum furnace for measuring electrical resistivity and thermoelectric power to 2200°C at 5×10^{-9} torr was demonstrated. (auth)

8732 (ORNL–4170, pp 42-4) THEORETICAL RESEARCH. Faulkner, J. S. (Oak Ridge National Lab., Tenn.).

The program of band-theory calculations has proved very promising and is being pursued. Crystal-field theory calculations and one-center molecular calculations are continuing. (auth)

8733 (ORNL–4170, pp 45-8) SPECTROSCOPY OF IONIC MEDIA. Smith, G. P. (Oak Ridge National Lab., Tenn.).

Hydrogen reduction of Bi(III) in molten $AlCl_3$–NaCl permitted measurement of the ultraviolet absorption spectrum of Bi^+ without interference from Bi^{3+}. Visible and near-infrared spectra of Bi^+ in bromide melts differed as expected from those in chloride. The formula of Bi_5^{3+} was confirmed. The spectra of Ni(II) in several media were interpreted in terms of two different coordination geometries in proportions that varied with temperature and medium composition. Also measured was a rate of oxidation of nitrite in molten LiClO and densities of molten $AlCl_3$ and its mixtures with NaCl. (auth)

8734 (ORNL–4170, pp 49-50) SUPERCONDUCTING MATERIALS. Love, G. R.; Picklesimer, M. L. (Oak Ridge National Lab., Tenn.).

Progress was made in the metallurgical characterization of several systems of potential interest in research in superconductivity. The equilibrium phase diagram was constructed for the binary system technetium-vanadium at temperatures up to 1500°C. The kinetics of eutectoid decomposition in alloys containing 30 at. % V is being investigated. The complex dependence of the fcc-dhcp transformation in lanthanum and cerium on time, temperature, grain size, cold work, and purity has been surveyed, and more detailed work is in progress. Magnetization data, including both critical-field and critical-temperature data, were obtained for the alloys of the technetium-vanadium system. Techniques have been developed for determination of critical parameters as a function of field strength and temperature in massive superconducting samples throughout the ranges 2 to 20°K and 0 to 75 kilogauss. (auth)

8735 (ORNL–4170, pp 51-3) SURFACE REACTIONS OF METALS. Cathcart, J. V. (Oak Ridge National Lab., Tenn.).

A study of the oxidation of nickel was undertaken to test the generality of a model for the oxidation of copper, which rationalized oxidation-rate anisotropy in terms of a corresponding anisotropy of the extent of short-circuit diffusion paths through the oxide. Results of x-ray, electron microscope, and optical studies of NiO films indicate that the oxidation model for copper also applies to nickel. Studies of the oxidation of refractory metals were continued. Oxygen was allowed to diffuse into niobium and tantalum at 800°C at several oxygen pressures, and the buildup of a substantial and complicated stress system was observed. The permeation of anodic Ta_2O_5 films by oxygen was studied with particular attention to the inhibiting effects of phosphorus incorporated into the film to produce an oxide alloy. The Ta_2O_5–Nb_2O_5 oxide alloys were prepared by the anodization of tantalum-niobium alloys in anticipation of a study of the phase relations in the tantalum-niobium-oxygen system. A high-efficiency anodization technique for tungsten was developed and a chemical stripping solution tested preparatory to a study of low-temperature and short-circuit diffusion in that metal. (auth)

8736 (ORNL–4170, pp 54-62) X-RAY DIFFRACTION. Yakel, H. L. (Oak Ridge National Lab., Tenn.).

Investigations of mixed oxide compounds containing beryllia with a description of the crystal structure of $La_2Be_2O_5$ continue. This equilibrium phase contains only tetrahedrally coordinated beryllium atoms, in contrast to the trigonal coordination found in the nonequilibrium phases $Ca_{12}Be_{17}O_{29}$ and Y_2BeO_4. We have obtained a glass-like material from quenched melts in the sodium oxide–beryllium oxide system. Powder diffraction data are given for LiN_3. Some structural properties of irradiated spinel crystals are presented. Since the actual chemical composition proved to be $1MgO:3Al_2O_3$ rather than the ideal 1:1 composition, the lattice defects due to nonstoichiometry could trap radiation-produced defects and lead to smaller net lattice expansions than those found in irradiated alumina. The presence of measurable orientation-dependent small-angle x-ray scattering from neutron-irradiated copper crystals is reported. Mathematical procedures for correcting small-angle x-ray scattering data for the effects of finite slit height and width were developed, and computer programs were written to apply them. Pyrolytic graphite monochromators continue to show real promise in x-ray diffraction experiments. A new method is reported for experimentally determining thicknesses of thin unattached films with only the linear x-ray absorption coefficient required as a priori knowledge. A simple alternative to the

Ewald–von Laue dynamical theory of x-ray diffraction is described. The method involves the solution of a system of difference equations. (auth)

8737 (ORNL–4170, pp 65-79) PHYSICAL AND MECHANICAL METALLURGY OF HIGH-TEMPERATURE MATERIALS. Harms, W. O. (Oak Ridge National Lab., Tenn.).

Materials problems associated with high-temperature high-performance reactors for advanced propulsive and electric power systems, especially for space applications, are outlined. Particular emphasis is placed on fabrication and complete physical metallurgical evaluation of tantalum-, niobium-, and molybdenum-base alloys. In creep-rupture investigations the niobium-modified molybdenum alloy TZM, after solution annealing at 1930°C and warm working at 1370°C, was the strongest of all alloys tested in the temperature range 980 to 1315°C. After annealing at 1600°C and aging 3 hr at 1200°C, SU 16 was the strongest niobium-base alloy in this temperature range. The 1000-hr creep-rupture behavior of T-222 was comparable to that of T-111 and Ta–10% W at 980 to 1650°C; welded specimens were slightly stronger than base-metal specimens. Larson-Miller parameters were derived for rupture of T-111, FS-85, and TZM, using a cubic polynomial in the logarithm of stress. Creep curves were obtained for molybdenum specimens during irradiation at 705, 760, and 870°C at stress levels of 18,000, 30,000, and 15,000 psi respectively. The resistance of the niobium alloy D-43 to cyclic strain at 1205°C was as good as or better than that around room temperature. Significant changes in the mechanical properties of tantalum-base alloys like T-111 that occur on cooling from annealing temperatures were attributed to the distribution of carbon. The diffusivity of nitrogen in Nb–1% Zr was described by the equation $D = 1.4 \times 10^{-5} \exp(-42{,}000/RT)$ and is about three orders of magnitude lower than in unalloyed niobium. Studies on the vaporization of Haynes alloy No. 25 in vacuum between 870 and 1150°C have been extended to include the effects of superimposed stresses on the evaporation kinetics and the determination of the creep properties of this alloy during evaporation. The effects of embrittling aging reactions in gas tungsten-arc welds of the niobium-base alloys Cb-752 and Cb-753 were evaluated in terms of microhardness traverses. Bend transition temperatures for weld specimens of the niobium-base alloy SU 16 were 90°C after electron-beam welding and 230°C after gas-tungsten-arc welding. Brazing alloys were developed for refractory-metal joining, and impressive shear strengths near 20,000 psi were observed to temperatures within 200°C of their melting points. The brazing alloy Ti–21% V–25% Cr proved outstanding in its ability to wet ceramics. Components of the niobium-base alloy D-43 were welded to form a large forced-circulation corrosion loop. A double arc-melting technique with intermediate extrusion was developed for production of homogeneous billets of the tantalum-base alloy T-111. Six extrusions—including tube shells, round rod, and sheet bar—were made, and the tube shells were subsequently swaged and drawn at room temperature. The thermal conductivity, electrical resistivity, and thermoelectric power of T-111 were determined at 100 to 1000°C; the hemispherical emittance was measured at 500 to 800°C. An analytical expression involving electrical conductivity was developed for extrapolation of the thermal conductivity to 1400°C. Thermal emf changes equivalent to less than 2°C were observed for Chromel-P vs constantan thermocouples after 400-hr exposures at 10^{-7} torr in the temperature range 300 to 800°C. The radiation exchange between graphite and anodized and Aquadag-coated aluminum was determined in connection with an irradiation test in the HFIR, where heat transfer by forced convection was not desirable. Techniques were developed and applied for non-destructive testing of refractory alloys. (auth)

8738 (ORNL–4170, pp 80-92) TUNGSTEN METALLURGY. Harms, W. O. (Oak Ridge National Lab., Tenn.).

In the tungsten and tungsten-alloy tubing fabrication development program, 37 billets were extruded at 1650 to 2200°C and extrusion ratios of 3 to 9. Significant process improvement was effected through modifications in the press controls and hydraulic system, the billet heater, and the mandrel design. The duplex extrusion technique was used to produce thin-walled tubing of W–25% Re and to develop a wrought structure in tubes of chemically vapor deposited (CVD) tungsten. Hot-plug drawing equipment and techniques were developed for secondary working of tubes to temperatures as high as 1000°C. An extruded duplex tube shell containing a CVD tungsten sleeve was reduced 85% in five passes at 700°C to 0.710-in.-OD × 0.01-in. wall thickness with no intermediate recrystallization anneals. Chemical vapor deposition studies included direct production of thin-walled tubing in lengths up to 4 ft, a statistical evaluation of deposition parameters as related to the structural features of the deposit and deposition-rate-controlling mechanisms, and an evaluation of the parameters controlling the uniformity of composition and properties in deposits of tungsten-rhenium alloys. Physical metallurgy studies on CVD tungsten containing up to 30 ppM F showed that bubbles formed during annealing at 1400°C develop from clusters or fine unresolvable precipitates of unidentified fluorine impurities in the as-deposited material. The morphology and growth characteristics of bubbles and their effect on metallurgical properties were investigated after heat treatments as high as 2500°C. The effect of stress on bubble growth was determined by electron microscopy of specimens creep-rupture tested at 1650 and 2200°C. The creep-rupture properties of wrought W–25% Re sheet prepared from arc-cast and from powder-metallurgy-derived materials were compared at 1650 and 2200°C. The arc-cast alloy was generally superior to the powder-metallurgy material, particularly with regard to rupture life and rupture ductility. Inflections related to yielding appeared in the load-deflection curves for tungsten annealed at various temperatures and tested in bending at temperatures just above the ductile-to-brittle transition temperature. The effects of annealing temperature and grain size on bend yield stresses were related to changes in substructure, impurity distribution, or perhaps even impurity content during annealing. Gas tungsten-arc welding formed reproducible, sound, pore-free welds in tungsten and tungsten alloys derived from arc-cast stock, but fusion-line porosity inevitably developed in powder-metallurgy-based alloys. Pore-free welds were also formed in CVD material containing 10 ppM F or less. The thermal conductivities and electrical resistivities of four tungsten and tungsten-alloy specimens were measured at –196 to 127°C. The results were treated by several methods to obtain the temperature dependence of the Lorenz number for calculating the electronic contributions to the thermal conductivity. (auth)

8739 (ORNL–4170, pp 97-102) NITRIDE FUELS DEVELOPMENT. Scott, J. L.; Harms, W. O. (Oak Ridge National Lab., Tenn.).

Development of nitride fuels for space-nuclear and liquid-metal fast-breeder applications continued. For the latter, properly designed (U,Pu)N fuel pins can operate at significantly higher linear heat ratings and power densities than mixed oxides and may have some advantages over mixed carbides. The development program involves fabrication, product characterization, thermodynamic studies, and compatibility testing. Plans are also under way for irradiation testing of the mixed nitride fuels. Fine dispersions are incorporated in UN to improve properties. In fabrication studies a process for producing UN pellets with less than 500 ppM O and 200 ppM C was developed. Low-oxygen-content uranium carbonitrides are also being produced. Abnormal grain growth in UN was found to be caused by traces of liquid uranium. A revised powder synthesis process eliminated this problem. Work with dispersed second-phase material in UN showed that the solubility of molybdenum in UN varies such that fine precipitate particles might be formed through careful heat treatment of sintered samples. It was shown that a fine dispersion of a thorium-rich oxide phase can be formed in a (U,Th)N alloy by internal oxidation. Thermodynamic studies have extended the range of measured nitrogen pressures over UN down to the practical temperature of 1300°C and have led to a value of –69.6 ± 1.0 kcal/mole for the standard enthalpy of formation of UN at 25°C ($\Delta H^0_{298,f}$). Studies on UC-UN solid solutions showed that the system is thermodynamically ideal, and the activity of carbon precipitated from UC by reaction with nitrogen below 1700°C is greater than that of graphite. Studies of the kinetics of the reaction of UC with nitrogen showed that the reaction occurs in two stages with a unique composition at a way station. In related studies, sintered pellets of a desired composition of U(C,N) were prepared by the reaction of graphite with UN in a pressed compact. (auth)

8740 (ORNL–4170, pp 105-7) DISPERSION IN SOLIDS. Hammond, J. P. (Oak Ridge National Lab., Tenn.).

Boronating thorium powders containing 4.65% Zr in solid solution gave a product twice as hard at 800°C as competitive alloys. Preliminary studies showed that modified Ni chrome- and Vitallium-type alloys containing thorium can be internally oxidized to give an ultrafine dispersion of very stable oxide particles. Good dispersion structures and high-temperature strength were achieved. (auth)

8741 (ORNL–4170, pp 119-23) NONDESTRUCTIVE TEST DEVELOPMENT. McClung, R. W. (Oak Ridge National Lab., Tenn.).

Development of analytical techniques for the calculation of parameters for an induced electromagnetic field are the computerized relaxation method and a closed-form solution. The first is more versatile and the second method has greater accuracy. Additional evaluation of complex integrals is necessary before the closed-form solution can be fully used. A portable phase-sensitive eddy-current instrument was developed with excellent lift-off compensation, sensitivity, and temperature stability. Probes for measurement of coolant-channel space for use in hot cells were improved. Ultrasonic response for various types of reference discontinuities used for the inspection of sheet and tubing are correlated. Improvements were made on techniques for fabricating both longitudinal and transverse notches in tubing. Both schlieren and photoelastic methods were used for viewing ultrasound. Quantitative data for the radiography of graphite and measuring radiographic sensitivity of metals as various parameters are formed. X-ray energy, specimen thickness, and the presence and thickness of lead screens are varied. (auth)

8742 (ORNL–4170, pp 151-7) BONUS REACTOR FUEL ELEMENT DEVELOPMENT. Franco-Ferreira, E. A. (Oak Ridge National Lab., Tenn.).

Improvement of BONUS Fuel Elements is reported. Fuel rod spacer brazing, fuel rod end-cap welding, and pressure-shell assembly brazing are discussed. An ultrasonic technique was developed for inspecting tube-to-spacer brazed joints. New methods are being used to screen structural alloys for weldability. (auth)

8743 (ORNL–4170, pp 160-1) EVALUATION OF HASTELLOY N FOR SNAP-8 SERVICE. McCoy, H. E. Jr.; Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.).

The development of improved versions of the SNAP-8 reactor requires a detailed knowledge of the postirradiation mechanical properties of Hastelloy N at 600 to 800°C. Compositional modifications of Hastelloy N for improved resistance to radiation embrittlement will probably be required. The postirradiation properties of Hastelloy N tubing and rod material from similar heats were consistent. The ductility and strength of the heats were reduced to low values at 650 and 760°C, although the strain-rate sensitivity of the effects differed at these temperatures. (auth)

8744 (ORNL–4170, pp 184-91) HIGH FLUX ISOTOPE REACTOR TARGET DEVELOPMENT. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

The goal of the Transuranium project is to produce gram quantities of the heavier transuranium elements for research purposes by successive neutron captures in ^{239}Pu. The ^{239}Pu was converted to ^{242}Pu, ^{243}Am, and ^{244}Cm in Savannah River reactors. At ORNL these products were fabricated into target elements that are being irradiated in the High Flux Isotope Reactor at a flux of approximately 3×10^{15} neutrons cm^{-2} sec^{-1}. The target elements are removed periodically from HFIR and reprocessed in the TRU to separate the product actinides and recover the target actinides, which are fabricated into recycle targets and returned to HFIR for further irradiation. Tasks have included the design, fabrication, and validation of suitable targets, the development of equipment and techniques for fabricating them, and monitoring their performance in HFIR. Because of the premature failure of target elements exposed in the HFIR, the cause of failure and fabrication of modified target elements that may withstand the HFIR service conditions were investigated. An irradiation program in the ETR for confirmation of the HFIR target element design was completed. The necessary ^{242}Pu targets for the HFIR irradiations were fabricated. Cold testing of the equipment in the TRU was completed and targets that had been irradiated previously at Savannah River were refurbished. An investigation of the mechanism of failure of targets that had been irradiated at Savannah River and in the HFIR to fission of approximately 25% of the plutonium was initiated. One solution to the HFIR target failures is being investigated. Target elements containing lower loadings and greater pellet porosity have been fabricated and are being irradiated in the HFIR. (auth)

8745 (ORNL–4170, pp 238–44) ROVER ROCKET NOZZLE MATERIALS. Franco-Ferreira, E. A. (Oak Ridge National Lab., Tenn.).

Hastelloy X tube bundles simulating rocket nozzles were cycled between –200°F and elevated temperatures; endurance was related to temperature, hold time, and the presence of dents on the tubes. Shear-stress-strain curves were compared for unirradiated and neutron-irradiated Hastelloy X joints brazed with three different alloys. Tensile properties were measured at elevated temperatures for Hastelloy X and Allvac 625. Participation in a review of the effects of space environment on nuclear rocket materials led to starting an investigation of the effects of gaseous contaminants on adhesion of initially atomically clean surfaces. (auth)

8746 (ORNL–4170, pp 245-7) THERMONUCLEAR PROJECT. Clausing, R. E.; Leonard, W. J. (Oak Ridge National Lab., Tenn.).

The decision to use superconducting magnets has made the design of components for use at liquid-helium temperatures necessary. A weldability study of the 5083 aluminum alloy is summarized. Because of the importance of adsorbed gases in determining the vacuum conditions in many experimental thermonuclear devices, the desorption of gases by electron bombardment is of interest. The desorption of hydrogen, deuterium, and carbon monoxide from tungsten by electron impact is being studied. The yields of hydrogen are of the order of 2×10^{-4} molecules per incident electron (1000-eV electron energy) when the specimen is at room temperature (with molecular hydrogen adsorbed) and about 2×10^{-5} when the specimen is at 1200°K (i.e., only dissociated hydrogen is present on the specimen surface). The yields increase rapidly with voltage above 300 V. The room-temperature yields for deuterium are similar to those for hydrogen, while the yields of carbon monoxide are more than an order of magnitude higher. (auth)

8747 (ORNL-TM–1994) CREEP–RUPTURE PROPERTIES OF UNALLOYED TANTALUM, Ta–10 PERCENT W AND T-111 ALLOYS. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405–eng-26. 20p. Dep. CFSTI.

The long-time, high-temperature creep properties of unalloyed tantalum, Ta – 10% W, and T-111 (Ta – 8% W – 2% Hf) were studied at 1204, 1427, and 1649°C. The Ta – 10% W and T-111 were much stronger than unalloyed tantalum. The properties of Ta – 10% W and T-111 were almost equal for the thermomechanical histories studied. The ductilities of all three materials were excellent. (auth)

8748 (UCRL–17832) AN ASSESSMENT OF THE USE OF DIMENSIONAL CHANGES TO DETERMINE GRAIN STRAIN DURING CREEP. Langdon, T. G. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405–eng-48. 23p. (CONF-671010–2). Dep. CFSTI.

From American Institute of Mechanical Engineers Meeting, Cleveland, Ohio.

An assessment of the use of dimensional change was made to determine grain strain of polycrystalline materials during creep by using a grid photographically printed onto the specimen surface. Analysis of the grid led to accurate determination of the grain strain, ϵ_s, occurring during creep, and hence the grain boundary sliding contribution, γ. To permit the use of measurements of offsets occurring perpendicular to the surface ($\bar{v}_r$) for the calculation of γ, an average value of $k = 1.07$ was obtained experimentally for use in the equation $\epsilon_{gb} = kn_r\bar{v}_r$. The values of k appeared to be independent of stress and grain size, but dependent on the total strain and the type of surface (i.e. whether "cut" or "annealed"). Values of γ determined by the grain shape technique were usually ~2 – 4 times larger than those obtained from offset measurements, although there appeared to be some agreement for those specimens in which the sliding contribution was initially very small (<20%). A comparison of ϵ_s determined by the grain shape technique and by measuring the dimensional changes of a printed grid contained within individual grains confirmed that migration was tending to round off the grains. It is suggested that the grain shape technique is inaccurate for determining the grain boundary sliding contribution, except possibly in those cases in which the sliding contribution is very small. (auth)

8749 (AD–652470) ACADEMY OF SCIENCES OF THE USSR. INSTITUTE OF METALLURGY. (SELECTED ARTICLES). Translated from Tr. Inst. Met. im. A. A. Baikova, Akad. Nauk SSSR, No. 10, 11-23; 147-52(1962). 33p. (FTD-MT–65–421). CFSTI.

In the first article it is shown that the existing theories of fatigue (work hardening, hardening and softening, dislocatory and energy) are deficient because they were developed through work only on structural factors or only on energy presentations about the development of the process of fatigue. A proposed theory considers both the structural changes occurring in the metal and the energies required for processes in different periods of fatigue. This theory is based on the energy of destruction being independent of how the energy is supplied. The processes of destruction, plastic deformation, and fusion are compared, and the obtained dependences are analyzed. Using the new regularities of fatigue herein established allows a substantial reduction in fatigue-test time and in calculating the curve of the start of damage susceptibility in metals. In a second article the effects of fatigue of high-carbon steels such as U12A, U10, U9A, alloy-steel 40Kh and heat-resisting alloy E1435 on their electromagnetic (total energy losses on magnetic hysteresis and eddy currents) and mechanical (microhardness and cyclic strength) characteristics and microstructure as determined by optic and electron microscope are examined along with the interconnection of these characteristics in the process of fatigue. The samples were tested during bending with rotation. The process of fatigue is divided into four periods and they are described. The electromagnetic and mechanical characteristics changed continuously, and the changes under the effect of sign-alternating stresses indicate a close connection between these characteristics. These changes depict the development of distortions of the crystal lattice, which lead to work hardening and then to the softening of the metal. Laboratory and industrial tests showed the effectiveness of the method for determining the place and degree of fatigue. (tr-auth)

8750 (AD-658385) MACHINING REFRACTORY AND RARE-EARTH METALS (SECTION V). Danielyan, A. M.; Bobrik, P. I.; Gurevich, Ya. L.; Egorov, I. S. Translated from pp 212-308 of Obrabotka Rezaniyem Zharoprochnykh Staley Splavov i Tugoplavkikh Metallov, 1965. 90p. (FTD-MT-65-584; TT-6500004). CFSTI.

Machining of refractory metals is discussed. Physical-mechanical and chemical properties are summarized. Methods of machining, treatment, types of cutters, and safety procedures for various metals are described. (auth)

8751 FRICTION CHARACTERISTICS OF GRAPHITE AND GRAPHITE-METAL COMBINATIONS AT ROOM AND ELEVATED TEMPERATURES. Manjoine, M. J. (Westinghouse Astronuclear Lab., Pittsburgh). pp 251-71 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5-7, 1967. See CONF-670601.

The low friction of graphite is attributed to a gas film on surface platelets. The surface finish, therefore, greatly influences the "wear-in" characteristics. When one of the surfaces is graphite, the static coefficient of friction at room temperature in air, hydrogen, or vacuum will wear-in to a value of about 0.18 for surface pressures within the "elastic" range. When the temperature is increased, the coefficient for graphite combinations in hydrogen decreases, the static value being about 0.1 at 4000 F. The temperature effect is reversible, and the coefficient increases on cooling and returns to nearly the same room temperature value. The coefficient of friction for graphite-metal combinations decreases with the temperature until a surface reaction occurs, after which it increases. Removal of the surface film by outgassing at 2540°F in a vacuum causes an increase of the static coefficient (in a vacuum at room temperature) from the original value of about 0.18 to over 0.4. The coefficient is reduced back to about 0.18 when hydrogen is admitted to the surfaces, thus restoring the gas film. Niobium carbide on niobium carbide has a room temperature static coefficient of friction in air, hydrogen, or vacuum of 0.19. The coefficient increases with temperature, reaching a value of unity near 3500°F. (auth)

8752 FRICTION EVALUATION OF MATERIALS FOR NUCLEAR ROCKET VALVE APPLICATIONS. Lamvermeyer, D. J.; Emmons, W. F. (Aerojet-General Corp., Sacramento, Calif.). pp 272-87 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5-7, 1967. See CONF-670601.

Fourteen candidate metallic and coating combinations for sealing surfaces of nuclear rocket valves were tested for galling and friction characteristics. A metal-machining lathe was adapted for this evaluation by instrumenting it to measure normal and drag forces which were used to calculate coefficients of friction. Testing was conducted to simulate valve opening and closing under initial 18,000 psi contact stress and a 26 ft/min sliding surface velocity at ambient temperature in an inert helium gas atmosphere. Superior results were obtained with the proprietary, vapor-deposited chromium "Electrolize" coating in contact with either thin gold (electrodeposited) plate or with phenolic-bonded molybdenum disulfide applied to a full-hard 301 stainless steel substrate. The gold coating was selected for this application based upon its superior nuclear radiation resistance. Metallurgical characteristics of the material combinations are discussed. (auth)

8753 VISCOSITY PREDICTION FOR ALKALI METALS. Weatherford, W. D. Jr. (Southwest Research Inst., San Antonio). pp 320-35 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5-7, 1967. See CONF-670601.

A method for estimating the influence of molecular momentum on the collision diameter of molecules is described and applied to the prediction of fluid viscosities. This viscosity model is correlated with experimental viscosities of several gases, liquid water, and liquid alkali metals, and it is utilized for estimating viscosities of alkali metal vapors. (auth)

8754 POSSIBILITIES OF USING METALLIC URANIUM AS A FUEL IN HEAVY WATER REACTORS. Djuric, Branko; Mihajlovic, Aleksandar; Drobnjak, Djordje. Nukl. Energ., 3: No. 6, 13-15(1966). (In Serbo-Croatian).

There are economic reasons for application of uranium metal in heavy-water reactors, first because of its high density, i.e., high conversion factor, and the low costs of fuel element production. The major obstacles are swelling at high burnup and the danger of corrosion. The requirements that the fuel must have a fine-grained random-oriented structure proved inadequate for the prevention of swelling. It seems likely that the solution of this problem should be sought in the prevention of the movement and accumulation of tiny fission-produced gas bubbles. This might be achieved through a suitable dispersion of the secondary phase in the bulk material. Fuel element designs may also, to considerable measure, lessen the harmful effects of fuel swelling. (auth)

8755 STRUCTURAL CHANGES AND COLD BRITTLENESS OF MOLYBDENUM DURING DEFORMATION. Belik, E. V.; Kaverina, S. N.; Minakov, V. N.; Trefilov, V. I. (Inst. of Physics of Metals, Kiev). Fiz. Metal. Metalloved., 24: 535-9 (Sept. 1967). (In Russian).

Structural changes and cold-brittleness temperature were measured following the high-temperature deformation of molybdenum. Correlations were made of the structure characteristics and conditions causing the fragility of the metal. (R.V.J.)

8756 THE INFLUENCE OF INDUCED RADIOACTIVITY ON THE DISSOLUTION AND HYDROGEN DRESSING OF ARMCO IRON IN MINERAL ACID SOLUTIONS. Spitsyn, Vikt. I.; Laptev, N. Ya.; Balezin, S. A. (Inst. of Physical Chemistry, Moscow. Moscow State Teacher's Inst.). Dokl. Akad. Nauk SSSR, 174: 143-6(May 1, 1967). (In Russian).

Samples of iron were irradiated at a neutron flux of 1.2×10^{13} neutrons cm^{-2} sec^{-1} for 14, 30, 65 and 90 days to give specific activities of induced ^{59}Fe of 1.5, 3.0, 4.3 and 5.4 mCi/g. The samples were 0.8 × 20 × 50 mm in size, and weighed about 6 grams. After the first 2 or 3 hours no noticeable difference could be observed between the radioactive and the nonradioactive samples after contacting with 5 $\underline{N}$ HCl. However with 5 $\underline{N}$ H_2SO_4 or 5 $\underline{N}$ $HClO_4$, the rate of dissolution of the radioactive sample was significantly less than that of the nonradioactive sample. Electrochemical measurements on the hydrogen overvoltage of the radioactive iron sample having a specific activity of 4.5 mCi/g showed a value of 18 to 20 millivolts higher than on the nonradioactive sample. (TTT)

8757 THE GRAIN-SIZE/CRACK-LENGTH-DEPENDENCE OF DUCTILE FRACTURE. Warren, M. R.; Beevers, C. J. (Univ. of Birmingham, Eng.). Metal Sci. J., 1: 173-7(Nov. 1967).

Zirconium-hydrogen alloys containing 25, 50, and 100 ppM hydrogen were tested at −196°C at a strain rate of 5×10^{-4}/ sec^{-1}. The grain size dependence of fracture stress for each alloy exhibited the relationship $\sigma = \sigma_0 + k_f d^{-1/2}$, where k_f was significantly reduced by increasing hydrogen content. The presence of the hydride precipitates caused the formation of cracks of variable length, L, and their influence on fracture stress, σ, could be represented by $\sigma_f = (E\gamma_p/\pi L)^{1/2}$, where $\gamma_p \simeq 10^5$ $ergs/cm^2$ was independent of the volume fraction of hydride precipitates. The grain size dependence of the fracture stress parameter, k_f, could be represented by $k_f = (E\gamma_p/\pi)^{1/2}(d/L)^{1/2} - \sigma_0 d^{1/2}$, where σ_0 is a term associated with the work necessary to grow cracks during plastic deformation. The interpretation of k_f is utilized to examine several instances where k_f is modified either by the presence of brittle second-phase particles or by a change in fracture mode with grain size. (auth)

8758 STRAIN BEHAVIOR IN UNIAXIALLY TESTED ZIRCALOY TUBING. Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Nucl. Mater., 24: 310-15(Dec. 1967). (ORNL-P-3267).

Tensile specimens of annealed Zircaloy tubing were tested to examine the influence of texture on anisotropy. It was found that the diameter and wall-thickness strains could be treated to give both a measure of the anisotropy of plastic properties and the texture of the tubing. (auth)

8759 DIFFUSION-CREEP IN MAGNESIUM ALLOYS. Vickers, W.; Greenfield, P. (English Electric Co. Ltd., Whetstone, Eng.). J. Nucl. Mater., 24: 249-60(Dec. 1967).

A magnesium-zirconium alloy, in which the zirconium was precipitated as zirconium hydride, was examined in creep at 400 to 450°C. Denuded zones are shown to form at grain boundaries normal to the applied stress and the size of these zones can account for the entire creep strain. The strain rate vs stress relationship is such, however, that the zones cannot be formed by diffusion creep. The published evidence purporting to show the importance of diffusion-creep in magnesium alloys at 450°C is reviewed. (auth)

8760 EFFECT OF CIRCUMFERENTIALLY ALIGNED HYDRIDE ON THE DUCTILITY OF ZIRCALOY-2 TUBING UNDER BIAXIAL STRESS. Hindle, E. D. (United Kingdom Atomic Energy Authority, Springfields, Eng.). J. Inst. Metals, 95: 359-63(Dec. 1967).

Zircaloy-2 tubing containing ~100 ppM hydrogen in the wall and having a hydride layer at the outside was tested from room temperature to 300°C. The circumferential strain to failure was progressively reduced from 14% at ~160°C to 1.5% at room temperature. Cracking of the hydride layers was observed and at strains ≥6% propagation into the underlying metal occurred. (auth)

8761 TUNGSTEN RESEARCH IN HUNGARY. **Millner, Tivadar. Magy. Tud. Akad. Muszaki Tud. Oszt. Kozlem., 38: 373-83(1967). (In Hungarian).**

Applied research on tungsten is aimed toward the development of wires suitable for incandescent bulbs, to be operated at elevated temperatures for long periods, supplying light as economically as possible. The best material for this purpose is prepared by powder metallurgy, adding trace elements, such as potassium, silicon and aluminum to pure tungsten, in amounts of the order of 10^{-4}%. The main subject of recent Hungarian research in this field concerned the study of the crystal growth attributable to the presence of the three-component impurity. An electron-microscope installation was developed to observe and photograph the wire specimens at high temperature, determining its temperature by an optical pyrometer. Electron emission studies of the wires revealed that the deformed crystallites possess a volume-centered cubic lattice; edge-dislocation phenomena do play an important role. The effect of the same impurity system was also studied in a tungsten–3% rhenium alloy. 25 references. (TTT)

8762 TUNGSTEN NEWS. Climax Tungsten, Tungsten News, June 1967. New York, Climax Molybdenum Co., 1967. 18p.

Tungsten metal is used for semiconductor supports, cathodes, electrodes, thermocouples, and tungsten halogen lamps. Fabrication of tungsten into structural materials is discussed along with brazing, properties, and uses of tungsten carbide. Tungsten-base alloys and their applications are discussed. Tungsten is alloyed with many elements. Discussions include alloys of tungsten with nickel, cobalt, chromium, tantalum, and columbium. Notes are given on the use of tungsten in high-alloy non-tool steels. Tungsten compounds other than carbides are discussed and the uses of these compounds summarized. A listing of 198 references is included. (J.C.W.)

8763 OSNOVY METALLURGII. TOM CHETVERTYI. REDKIE METALLY. **(Fundamentals of Metallurgy. Volume 4. Rare Metals). Greiver, N. S.; Sazhin, N. P.; Strigin, I. A. (eds.). Moscow, Izdatel'stvo Metallurgiya, 1967. 652p.**

Comprehensive data are presented on the physical and chemical properties, extraction, purification, uses, and metallurgical treatment of Mo, W, V, Co, Nb, Ta, Zr, Hf, Y, Sc, Ce, Te, Ga, In, Tl, Ge, Re and their oxides and compounds. An extensive list of references is included for each chapter. (R.V.J.)

8764 KINETICS OF HIGH TEMPERATURE OXIDATION OF METALS AND ALLOYS. **Pethe, L. D. Bombay, Bombay Univ., 1966.**

Thesis.

The transition from internal to external oxidation of the In–Ag and Sn–Ag alloy systems, at 400 to 800° and between 10–76 torr oxygen pressure, has been investigated. It has been shown that the above transition takes place at 10/90 In–Ag and 2/98 Sn–Ag alloys. The kinetic data have been supplemented by the electron diffraction and photo-micrography. The oxidation of Dy metal has also been studied at 500 to 800° at 100 torr oxygen pressure. The process is diffusion controlled. The radioactive inert marker indicated that the diffusion of oxygen vacancies is responsible for the oxidation of this metal. La metal is found to oxidize in accordance with the cubic rate law at 500 to 700° at 100 torr oxygen pressure. In the light of the present theories it is not possible to interpret the cubic oxidation of metals forming n-type semiconducting oxides, like La_2O_3. (Indian Sci. Abstr.)

Structure and Phase Studies

Refer also to abstracts 8047, 8061, 8720, and 8721.

8765 (ORNL-4170, pp 12-14) DEFORMATION OF CRYSTALLINE SOLIDS. **Williams, R. O. (Oak Ridge National Lab., Tenn.).**

Powerful analytical methods were developed for transforming x-ray texture data into axial or biaxial pole figures, which are required for the complete representation of fiber and sheet textures. Least-squares methods are applicable for the axial case, where one either solves for the coefficients of a series or else solves directly for the density function without recourse to a mathematical model. For the biaxial case, the same methods become very difficult, and an iterative method was much more satisfactory. The method was applied to rolling textures for copper, brass, and aluminum. Work is under way to establish the important parameters that control the strengthening in alloys exhibiting spinodal decomposition. Important parameters are considered to be the wave length, the degree of segregation, and the strains. Since fracture behavior is important in determining the mechanical properties, this is being investigated also. Very high deformation in copper and iron by rolling changed both the internal structure and the texture relative to more normal strains. Cross rolling altered both the texture and the structure. (auth)

8766 (ORNL-4170, pp 233-7) METALLOGRAPHY. Gray, R. J. (Oak Ridge National Lab., Tenn.).

The time-consuming task of obtaining quantitative metallography data has been replaced for most analyses by an image-analyzing computer. The data can be obtained directly from the specimen through a microscope, or with an attachment that accommodates all types of prints and negatives. Potentiostatic etching is being investigated as a procedure for selectively etching and differentiating phases in the microstructure. In the early stages of experimentation, ideal alloys have been selected; however, sufficient work with more complex alloys indicates this procedure may be very helpful in microstructural analysis. By high-temperature microscopy we observed the transformation of UAl_3 to UAl_4 in an aluminum matrix. This observation of the shape change and wedging process of the fuel particles due to the transformation helped to explain the swelling problem. The development of a chemical, and electrolytic, and a protective oil method for specimen preparation extended our capabilities for metallographic examination of reactive CeC_2. (auth)

8767 (UCRL-Trans-10162) STUDY OF THE KINETICS OF AGING OF MOLYBDENUM-BASED ALLOYS. Gol'tsev, V. P. Translated by A. M. A. Mincer for Univ. of California Lawrence Radiation Lab., Livermore, from Dokl. Akad. Nauk SSSR, 10: 385-7(1966). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The kinetics of the dispersion hardening of Mo alloys and the nature and structure of phase separation were investigated by changes in hardening and in the lattice parameters. The nature and structure of the hardening phase was studied by x-ray phase analysis of the anodic precipitates of the alloys and from microdiffraction electronograms taken on adhering particles of the second phase. It was found that Mo-based alloys belong to the dispersion-hardening alloys, the hardening phase consists mainly of the oxides of the alloying elements. (F.S.)

8768 PHASE RELATIONS IN THE NIOBIUM–GALLIUM SYSTEM. **Oden, L. L.; Siemens, R. E. (Bureau of Mines, Albany, Oreg.). J. Less-Common Metals, 14: 33-40(1968).**

Niobium–gallium alloys and diffusion couples were studied in the composition range 0 to 70 wt % by metallography, thermal analysis, electron microprobe, and x-ray diffraction. Five intermetallic compounds were identified; their tentative formulas, modes of formation, and melting or decomposition temperatures are Nb_3Ga, peritectic, 1900 ± 20°C; Nb_3Ga_2, congruent, about 1800°C; NbGa, peritectic, 1490 ± 20°C; Nb_2Ga_3, peritectic, 1280 ± 10°C; $NbGa_3$, peritectic, 1240 ± 10°C. A eutectic reaction occurs between the first two compounds at 1750 ± 25°C and 25 wt % Ga. The solubility of Ga in Nb decreases from 12 wt % at 1900°C to about 7 wt % at 1600°C. (auth)

8769 ALPHA-PHASE PRECIPITATION IN DELTA-PHASE PLUTONIUM. **Knight, R. A.; Spicer, B. R.; Ward, B. J.; White, J. S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Mater., 24: 223-9(1967).**

An investigation has been made of the effect of cold treatment at –80°C upon the α-phase precipitation in a Pu–3 at. % Ga alloy cast into moulds held at various temperatures between 70 and 670°C. The casting conditions produced a cored δ-phase structure in which the cold treatment transformed the solute-deficient regions to the α phase. Alpha-phase precipitation produced a marked strengthening of the δ phase and it has been shown that the degree of strengthening depends upon the dispersion of the α phase. (auth)

8770 ELECTRON MICROSCOPIC STUDY OF PLUTONIUM. **Ekbom, L.; Johansson, U.; Tornqvist, M. (Forsvarets Forskningsanstalt, Stockholm). J. Nucl. Mater., 24: 230-1(1967).**

Thin foils of α Pu were prepared for electron microscope studies. The electron-diffraction pattern indicated, however, that the metal was oxidized to PuO_2 in those parts of the foil thin enough to transmit the electron beam; the grain structure was similar to that of α Pu. In some cases the lack of any diffraction pattern or structure showed that the material was amorphous. When these samples were heated locally by increasing the electron beam current, they recrystallized to a grain structure normal for fcc lattices. On further heating grain coarsening occurred, the foil edges melted, and holes of regular shape were formed. (A.G.W.)

8771 THE FORMATION OF POLYGONIZED SUBSTRUCTURE IN DEFORMED SINGLE CRYSTALS OF α ZIRCONIUM. **Dedo, A.;**

Mills, D.; Craig, G. B. (Univ. of Toronto). J. Nucl. Mater., 24: 237-9(1967).

An x-ray technique and a dislocation-etching technique were used to determine the temperature range where a polygonized substructure formed in deformed α Zr. The results indicate that dislocation climb and polygonization occur at 300°C and above. As the heat-treatment temperature is raised from 300 to 400°C, the time to produce polygonization is found to decrease. Decoration of the glide dislocations is necessary for observation of polygonization by the dislocation-etching technique. The atomic species responsible for the decoration probably has a diffusion coefficient similar to that for self-diffusion of Zr. (A.G.W.)

8772 EFFECT OF ROLLING TEMPERATURE ON THE TEXTURE DEVELOPED IN ROLLED ZIRCONIUM-RICH ALLOYS. Cheadle, B. A.; Ells, C. E. (Chalk River Nuclear Labs., Ontario). J. Nucl. Mater., 24: 240-4(1967).

Examinations were made of the texture of sheets of crystal bar Zr, commercial Zircaloy-2, and 2.5 wt % Nb–Zr alloy rolled 50% at room temperature, 400, 800, or 1000°C followed by air cooling. The results indicate that when Zr-rich alloys are rolled in the α phase a higher temperature makes the texture more intense. The mechanism of development of texture by rolling is apparently affected by Nb content. The mechanism of texture development when the alloys are deformed in the β phase is not known. (A.G.W.)

8773 OPTICAL CONSTANTS OF PLUTONIUM AT 5461 A. Larson, D. T.; Cash, D. L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Nucl. Mater., 24: 232-3(1967).

An ellipsometer was used to determine the optical constants for delta Pu at 5461 Å. A "clean" surface was produced by bombarding a polished Pu coupon in a vacuum system with argon ions until there was no further change in ellipsometer readings. Optical constants for five different samples are tabulated. The average value for the complex index of refraction at 5461 Å is 2.07–3.61 i. (A.G.W.)

8774 CONTRIBUTION TO THE THEORY OF CERIUM ISOMORPHIC PHASE TRANSFORMATION AND CRITICAL TRANSITION. Aptekar, I. L.; Ponyatovskii, E. G. (Inst. of Physics of Solids, Novosibirsk, USSR). Dokl. Akad. Nauk SSR, 173: 851-4(Apr. 1, 1967). (In Russian).

Data on cerium isomorphic phase transformation with temperature increase under pressure and reduced thermal transformation under increased pressure suggested the existence of a critical point in the cerium P–T diagram at 550°C and ~19 k bars. Theoretical analysis was made of P–V–T ratios in the critical processes in cerium. The theoretical studies were based on the assumption that at all temperatures except absolute zero the cerium is a solid solution of the two components A and B. The A component describes the tetravalent cerium and B the trivalent. The analysis of solid solution model describes the abnormalities observed in the contraction, thermal expansion, and other properties of cerium in the examined range. (R.V.J.)

8775 THE DISTRIBUTION OF EFFECTIVE FIELD AT THE ^{59}Co NUCLEI IN COBALT–NICKEL ALLOYS. Riedi, P. C.; Scurlock, R. G. (Univ. of Southampton, Eng.). Proc. Phys. Soc. (London), 92: 117-24(Sept. 1967).

The distribution of effective field was studied at 4.2°K by the spin echo technique. Satellite lines of the ^{59}Co resonance were observed in alloys of composition Co_cNi_{1-c} for $c \leq 0.10$ and $c \geq 0.93$, and broad distributions of effective field at intermediate compositions. The resonant frequency of cobalt nuclei with one and two nickel atoms in the nearest-neighbor shell is reduced by 7.5 Mc/s per nickel atom. The distributions of effective field in all the alloys can be reasonably well described by considering only the first-nearest-neighbor shell. (auth)

8776 MODIFICATIONS TO THE ORTHOGONALIZED-PLANE-WAVE METHOD FOR USE IN TRANSITION METALS: ELECTRONIC BAND STRUCTURE OF NIOBIUM. Deegan, R. A.; Twose, W. D. (McMaster Univ., Hamilton, Ontario). Phys. Rev., 164: 993-1005(Dec. 15, 1967).

Modifications to the orthogonalized-plane-wave (OPW) method are employed to facilitate its application to transition metals. The procedure is to augment the basis set of OPW's by including functions which vanish in the interstitial regions of the crystal but represent well the outer core functions and the d-band states near the nuclei. The bands are found to converge at a rate approximately the same as for the unmodified OPW method in semiconductors. The method is applied to calculate the conduction electron bands of niobium, along principal symmetry directions, to a convergence of about 0.01 Ry. The resulting band structure is very similar to previous augmented-plane-wave calculations for other bcc transition metals. (auth)

8777 FACE-CENTRED CUBIC MODIFICATION IN SPUTTERED FILMS OF TANTALUM, MOLYBDENUM, TUNGSTEN, RHENIUM, HAFNIUM, AND ZIRCONIUM. Chopra, K. L.; Randlett, M. R.; Duff, R. H. (Kennecott Copper Corp., Lexington, Mass.). Phil. Mag., 16: 261-73(Aug. 1967).

Stable face-centered cubic modifications of tantalum, molybdenum, tungsten, rhenium, hafnium and zirconium were observed in sputtered films of these metals deposited at ~200 to 400°C. The f.c.c. structure was found in films as thick as 2 microns, and on substrates of glass, mica and rock salt. A mixture of f.c.c. and the normal structure appear in thicker films. Perfect epitaxial growth of the f.c.c. phase with parallel orientation with respect to rock salt was observed in Ta, Mo and Zr films. The densities of the observed f.c.c. structures was lower than those of the normal structures, with a maximum decrease of 29.1% for Hf. At deposition temperatures exceeding 400°C, the normal structures were obtained in all cases. Transformation of the f.c.c. to the normal structure obtained by annealing at higher temperatures (~700°C). Thermally evaporated films also assumed f.c.c. structures which changed readily to the normal structures with increase of film thickness and substrate temperature. Stability of the f.c.c. structure in sputtered films may be the result of nucleation of this phase due to the high kinetic energy and the electrostatic charges carried by the sputtered atoms. Definitive evidence is presented to show that the observed f.c.c. structures are metallic modifications rather than f.c.c. nitride compounds. (auth)

8778 FORMATION OF SUBSTRUCTURE IN ALPHA-PLUTONIUM AT HIGH PRESSURES. Liptai, R. G.; Friddle, R. J. (Argonne National Lab., Ill.). J. Nucl. Mater., 24: 316-22(Dec. 1967).

Studies of the microstructure produced in plutonium after solid-state treatments or cooling from the liquid phase at pressures over 30 kbar are presented. Above 30 kbar, only the alpha and beta solid phases of plutonium exist. On cooling through the beta → alpha transformation, plastic deformations are produced. A discussion of the sources of these plastic strains is given. Strains resulting from the deformation apparently are relieved by the formation of substructure with low-angle boundaries, a process that may be broadly classified as polygonization. This behavior is similar to that of uranium. By control of the variables that lead to the formation of substructure, thermal treatments at high pressures can be used to grow large crystals of alpha-plutonium. (auth)

8779 EXPERIMENTAL METHODS OF MATERIALS RESEARCH. Herman, Herbert (ed.). Advances in Materials Research. Volume 1. New York, Interscience Publishers, 1967. 325p. $14.95.

Ten review articles are included; separate abstracts were prepared for six. Articles not abstracted include: Electron Microscopy, Field-Emission Microscopy, Electron-Probe Microanalysis, and Anelastic Techniques: Iron, a Case History. (M.H.R.)

For abstracts of individual sections see: 8780–8785

8780 X-RAY DIFFRACTION. Barrett, C. S. (Univ. of Chicago). pp 1-27 of Experimental Methods of Materials Research. Herman, Herbert (ed.). New York, Interscience Publishers, 1967.

Developments in the following areas over the past 15 years are covered: techniques in crystal structure analysis, crystal data compilations, powder data file developments, x-ray topographs, and specimen preparation by rapid cooling methods. (M.H.R.)

8781 NEUTRON DIFFRACTION. Shull, C. G. (Massachusetts Inst. of Tech., Cambridge). pp 29-50 of Experimental Methods of Materials Research. Herman, Herbert (ed.). New York, Interscience Publishers, 1967.

Three characteristics unique to neutron radiation, as opposed to other types of radiations normally used in diffraction studies, are emphasized. These neutron properties are (1) irregular scattering characteristics of atoms, (2) momentum-energy relation, and (3) possession of a magnetic moment by the neutron. These properties are described and typical applications of neutron radiation which have made use of these characteristics are given. (M.H.R.)

8782 APPLICATIONS OF THE MOESSBAUER EFFECT TO PROBLEMS IN MATERIALS SCIENCE. Flinn, Paul A. (Carnegie Inst. of Tech., Pittsburgh). pp 163-92 of Experimental Methods of Materials Research. Herman, Herbert (ed.). New York, Interscience Publishers, 1967.

The following topics are covered: experimental apparatus, applications in materials science, magnetic effects, applications to more complicated systems, application to lattice dynamics, and the study of defects and diffusion. (M.H.R.)

8783 LOW-TEMPERATURE DEFORMATION TECHNIQUES. Arsenault, R. J. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. pp 215-50 of Experimental Methods of Materials Research. Herman, Herbert (ed.). New York, Interscience Publishers, 1967. (ORNL-P-1449).

The methods of obtaining engineering data have increased from tension and impact testing to include fatigue, torsion, and biaxial testing. The techniques developed in recent years are discussed in detail together with advantages and disadvantages of each. A number of different techniques developed to study dislocation mechanisms, both in microyield and macroflow regions, are covered. From these techniques, a better understanding of the rate-controlling mechanisms and the mechanisms of work hardening is emerging. (M.H.R.)

8784 DETERMINATION OF THE STORED ENERGY OF DEFORMATION OF METALS AND ALLOYS. Williams, R. O. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. pp 251-78 of Experimental Methods of Materials Research. Herman, Herbert (ed.). New York, Interscience Publishers, 1967. (ORNL-P-1010).

The problems of energy measurements are defined. The methods which have been used are discussed and compared, in order that existing results may be evaluated and additional measurements made. (M.H.R.)

8785 SOME EXPERIMENTAL ASPECTS OF DIFFUSION IN METALS. Tomizuka, C. T. (Univ. of Arizona, Tucson). pp 279-99 of Experimental Methods of Materials Research. Herman, Herbert (ed.). New York, Interscience Publishers, 1967.

The mechanism of diffusion, quenched-in vacancies, self-diffusion, and diffusion at high pressures are discussed. (M.H.R.)

8786 IZUCHENIE DEFEKTOV KRISTALLICHESKOGO STROENIYA METALLOV I SPLAVOV. (Studies of Crystalline Structure Defects in Metals and Alloys). Svechnikov, V. N. (ed.). Respublikanskii Mezhnedomstnennyi Sbornik. Seriya Metallofizika. Kiev, Izdatel'stvo Naukova Dumka, 1966. 144p.

Eighteen chapters are included. A separate abstract was prepared for four chapters. The remaining fourteen chapters were omitted from NSA. (R.C.K.)

For abstracts of individual chapters see: 8800-8803.

Radiation Effects

Refer also to abstracts 8198, 8627, 8731, and 9242.

8787 (GEMP-563) DISLOCATION HALOS IN AN IRRADIATED NICKEL-BASE ALLOY. Rau, R. C.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). [1967]. Contract AT-(40-1)-2847. 7p. (CONF-680202-1). Dep. CFSTI.

For Presentation at 97th Annual Meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers, New York.

Transmission electron microscopy has been used to examine a neutron irradiated nickel-base alloy which had been doped with boron enriched in the ^{10}B isotope. These observations show concentric circular halos of dislocations, many of them loops, surrounding some of the carbide precipitates in the specimens. These halos are believed to be planar segments of spherical damage shells surrounding regions of ^{10}B concentration, and are concluded to represent the resting points of helium and lithium atoms produced by the $^{10}B(n,\alpha)^{7}Li$ reaction. (auth)

8788 (ORNL-4170, pp 115-18) MECHANICAL PROPERTIES RESEARCH. Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.).

Radiation damage to the mechanical properties of reactor materials and the development of modified alloys more resistant to radiation damage are studied. It is found that the in-reactor and postirradiation creep properties of type 304 stainless steel are comparable. However, the rupture life and ductility in both cases were significantly less than those of unirradiated material. The development of titanium-bearing type 304 stainless steel has continued through the investigation of small (100 lb) and medium sized (1500 lb) heats. The results among the various heats are consistent, and the mechanical properties show considerable improvement over conventional type 304 stainless steel after reactor and alpha-particle irradiations. Irradiation experiments for insertion into EBR-II are being prepared. The first experiments to determine the nuclear heating rate in the reactor have been designed and constructed and are at the EBR-II site awaiting installation in the reactor. Subsequent experiments are under construction. (auth)

8789 EFFECT OF NUCLEAR RADIATION ON THE PERFORMANCE OF LIQUID HYDROGEN COOLED ROLLING ELEMENT BEARINGS. Accinelli, J. B.; Andrews, F. X. (Aerojet General Corp., Sacramento, Calif.). pp 492-503 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5-7, 1967. See CONF-670601.

The results of tests with 50 mm ball and roller bearings operating in liquid hydrogen within a nuclear radiation environment are presented. The bearings were of the same size and type as those used in the NERVA Technology Turbopump and were operated adjacent to a 10 megawatt reactor in a unique tester driven by an integral LH_2-cooled electric motor. Two 60-minute irradiation tests, each of which gave an integrated gamma dose of about 10^9 ergs/gm(C) measured at tester exterior. The ball bearings which were equipped with FEP Armalon retainers completed the radiation tests satisfactorily, but failed by retainer ball pocket rupture during the post-radiation run. The roller bearings equipped with TFE Armalon retainers performed satisfactorily. It is believed that the cylindrical roller bearings, which are less demanding of the retainers than the heavily loaded ball thrust bearings, and that TFE Armalon which is slightly less sensitive to radiation damage, contributed to the observed difference in performance. Neither material is expected to be satisfactory for use in higher radiation environments. A discussion of the mechanism which limits bearing operation in this environment is presented. (auth)

8790 INFLUENCE OF ELECTRONIC RADIATION ON THE MECHANICAL PROPERTIES OF HIGHLY RESISTANT STEEL. Prusakov, B. A.; Prokoshkin, D. A.; Bystrov, L. N.; Ivanov, L. I. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 176: 567-70(Sept. 21, 1967). (In Russian).

Effects of ~2.5 MeV electron irradiation on mechanical properties of steel (0.38% C, 5.12% Cr, 0.66% Mn, 0.79% Si, 1.3% Ni, 0.75% Mo, 0.27% V, and 0.99% W) were studied. Diagrams illustrating the variations of mechanical properties as a function of irradiation time following low-temperature mechanical treatment are included. (R.V.J.)

8791 INVESTIGATION OF THE HIGH-TEMPERATURE EMBRITTLEMENT OF 16/13 CrNi STEELS AFTER NEUTRON IRRADIATION. Boehm, H.; Hauck, H.; Hess, G. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 24: 198-209(1967). (In German).

The effects of B content, C content, and a combined mechanical-heat treatment, on the high-temperature embrittlement of austenitic 16/13 CrNi steels after neutron irradiation were investigated. The results established that the tensile ductilities of the irradiated specimens are independent of the boron content (in the studied concentration range) whereas an increasing carbon content improves the postirradiation ductility because of increasing carbide precipitation. It is further shown that the high-temperature embrittlement of the steel X8CrNiMoVNb 1613 is affected a combined mechanical-heat treatment. The postirradiation ductility is improved by heavy cold working prior to annealing. This effect may be related to the increased numbers of fine dispersed carbide particles. (auth)

8792 EXPERIMENTS ON THE URANIUM EMISSION FROM SINTERED URANIUM OXIDE PELLETS. Ferrari, S.; Segre, G. J. (CNEN, Rome). J. Nucl. Mater., 24: 150-7(1967).

Experiments were carried out to determine the emission of uranium from uranium oxide under irradiation. The determination of the emitted material was carried out by α counting aluminum thin foils that had acted as catchers during irradiation, and by electron microscopy. A tentative phenomenological interpretation is reported. (auth)

8793 COMPARISON OF MICROSTRUCTURE WITH MECHANICAL PROPERTIES OF IRRADIATED TUNGSTEN. Rau, R. C.; Moteff, J.; Ladd, R. L. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater., 24: 164-73 (1967).

Transmission electron microscopy has been used to study the microstructure of mechanically tested polycrystalline tungsten irradiated to fast ($E > 1$ MeV) neutron fluxes ranging from 8.5×10^{17} to 1.5×10^{21} n/cm^2. A flux threshold exists between 5.9×10^{18} and 3.8×10^{19} n/cm^2 ($E > 1$ MeV), above which distinct defect-cluster formation occurs. These clusters appear to contribute to the hardening of the material, leading to embrittlement in tensile specimens tested at 400°C. The microstructure of irradiated tungsten subsequently exposed to creep-rupture testing at 1100°C showed the presence of distinct dislocation loops thought to result from interstitial aggregation. Although the microstructural features observed in irradiated tungsten appear to be related to fast ($E > 1$ MeV) neutron flux rather than thermal neutron flux, the irradiation-induced strengthening observed at 1100°C shows better correlation with thermal neutron flux. The presence of rhenium and osmium atoms produced by thermal-neutron transmutation reactions is believed to account for the property changes at 1100°C. (auth)

8794 THROUGH-THICKNESS NOTCH DUCTILITY AND TENSION PROPERTIES AS A FUNCTION OF NEUTRON EX-

POSURE TO A SIMULATED PRESSURE VESSEL WALL OF A302-B STEEL. Serpan, C. Z. Jr.; Hawthorne, J. R. (Naval Research Lab., Washington, D. C.). Nucl. Eng. Design, 6: 78-88(Aug. 1967).

Notch ductility and tension property measurements have been made using specimens irradiated within a large steel test assembly simulating the pressure vessel wall of a light-water moderated power reactor. The A302-B steel specimens, spaced at intervals through the 6-inch thickness of the assembly, showed the greatest embrittlement and tensile property changes from irradiation locations nearest the fuel core, and correspondingly smaller changes farther from the core. Measured fluxes, stated in terms of neutrons > 1 MeV based upon an assumed fission spectrum, compared well with calculated neutron fluxes > 1 MeV for all test assembly locations, thus providing the basis for future estimates of property changes through the thickness of heavy-walled reactor pressure vessels. (auth)

8795 RECOVERY OF DEUTERON-IRRADIATED PLATINUM. Jackson, James J. (Argonne National Lab., Ill.); Herschbach, Kornelius. Phys. Rev., 164: 951-65(Dec. 15, 1967).

Pure, well-annealed platinum specimens and platinum specimens containing quenched-in vacancies were bombarded near 5°K with 20-MeV dueterons. Both damage production and recovery were studied. The quenched-in vacancies increase both the initial production rate and the fall in this rate with increasing deuteron dose. A model based upon defocusing at divacancies is used to explain these features. Recovery of the damage occurred in four main stages. The excess vacancies affect the amount of recovery and/or the temperature of maximum recovery rate in each stage. Recovery also depends on the dose. The principal annealing processes in each stage are identified as: stage I, close-pair recombination and free migration of interstitials; stage II, release of mobile interstitials from traps; stage III, migration of a second type of interstitials; stage IV, vacancy migration. (auth)

8796 INFLUENCE OF REACTOR IRRADIATION OF SURFACE CORROSION OF PURE IRON. Teodorescu, I.; Zberea, I. (Inst. of Atomic Physics, Bucharest). J. Nucl. Mater., 24: 347-9(Dec. 1967).

Sheets of polycrystalline iron of high purity (99.998%) were irradiated in a reactor to study changes in surface structure due to irradiations. Heat-treated samples before irradiation showed a structure with pyramidal reaction products. Irradiation led to a fine structure with globular form, either on pyramid surfaces or on the areas between the pyramids. If the pressure in the irradiation tube reached atmospheric, highly disordered layer buildup which masks partially or totally the existent structure before the irradiation, was observed. Corrosion was more obvious on samples chemically or electrolytically polished. (M.C.G.)

8797 CATION SELF-DIFFUSION IN FAST NEUTRON-IRRADIATED BERYLLIUM OXIDE. de Bruin, H. J. (Oak Ridge National Lab., Tenn.); Watson, G. M.; Blood, C. M.; Roman, D. Phil. Mag., 16: 427-30(Aug. 1967).

A considerable enhancement of beryllium self-diffusion rates in irradiated polycrystalline beryllium oxide was observed, which was strongly time-dependent above 800°C. Among possible mechanisms, increased point defect concentrations and long-range disorder due to lattice expansion could account for the observed enhancement. (auth)

8798 FISSION FRAGMENT DAMAGE TO METALLIC CRYSTALS. II. ORDERED COPPER–GOLD ALLOY. Van Vliet, D.; Chadderton, L. T. (Cambridge Univ., Eng.). Phil. Mag., 16: 291-5(Aug. 1967).

The effect of fission fragment irradiation upon an ordered alloy was studied by the direct resolution in the electron microscope of the super-lattice fringes associated with the copper–gold alloy CuAu II. At low doses a random array of small defect clusters was observed, but no tracks or linear disordering associated with the passage of a fission fragment were noted. Large doses caused virtually complete disordering, suggesting that the clusters observed at lower doses are three-dimensional regions of disorder associated with individual displacement spikes. (auth)

8799 DISLOCATION PINNING IN NEUTRON-IRRADIATED O.F.H.C. AND 99.999 PERCENT COPPER. Queen, T. J. (Univ. of Strathclyde, Glasgow). Phil. Mag., 16: 297-302(Aug. 1967).

Internal friction studies were carried out on neutron-irradiated copper of two purities: O.F.H.C. copper of 99.95% nominal purity and 99.999% copper. The specimens were annealed isochronally from room temperature to 200°C, and two pinning stages were observed at 70 and 150°C. The 70°C stage was stronger in the 99.95% copper than in the purer copper, and the pinning in this stage was found to be governed by an activation energy of 1.03 ± 0.07 eV. It is thought that this pinning is due to the migrations of vacancies released from traps. The logarithmic decrement was found to have a $t^{1/2}$ dependence, and it is calculated that the vacancies make 10^3 jumps before reaching a dislocation. (auth)

8800 IONIZING RADIATION EFFECTS ON THE ATOMIC MOBILITY OF METALS AT ROOM TEMPERATURE. Dekhtyar, I. Ya.; Pilipenko, V. V.; Shalaev, A. M. (Inst. of Metal Physics, Kiev). pp 58-62 of Izuchenie Defektov Kristallicheskogo Stroeniya Metallov i Splavov. Svechnikov, V. N. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1966. (In Russian).

The results of the investigation of the effects of γ and electron irradiation on the diffusion of Co in Pb, Ni, Ti, and Fe were reported. The samples were irradiated at room temperature at dose output of 3400 r/sec. The electron dose output was 1.3×10^{13} electrons/cm^2 sec at electron energy of 2 MeV. The results are tabulated and show that the integral β activity is reduced with increase of the γ and electron irradiation. Corresponding calculations show that the increase of the diffusion coefficient agrees with the increase of the temperature for the diffusion of Co in Fe up to 570°C and in Ti up to 220°C. (tr-auth)

8801 RADIATION EFFECTS ON CERTAIN PROPERTIES OF NIOBIUM AND NIOBIUM ALLOYS. Markovskii, E. A.; Chernyi, V. G.; Tikhonovich, V. I.; Krasnoshchekov, M. M.; Nedyukha, I. M. (Inst. of Metal Physics, Kiev). pp 106-10 of Izuchenie Defektov Kristallicheskogo Stroeniya Metallov i Splavov. Svechnikov, V. N. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1966. (In Russian).

The effect of neutron irradiation on the mechanical properties of Nb and its alloys depends on their purity. Difference in the hardness of the irradiated materials is probably connected with the unequal degree of structure defects in the original state. The neutron current at the energy given leads to the formation of a definite quantity of defects. If the material originally contained a large number of defects, then the neutron irradiation does not lead to the formation of new defects and strengthening does not occur. Neutron irradiation leads to changes in the antifriction characteristics of Nb of electron-beam melts. The change in the character of its interaction with counter-substances appears in friction processes as a result of the increase of the number of defects in its structure. (tr-auth)

8802 PROPERTIES OF NEUTRON-IRRADIATED CAST INDUSTRIAL STEEL ML5. Meshkov, V. N.; Konozenko, I. D. (Inst. of Physics, Kiev). pp 122-7 of Izuchenie Defektov Kristallicheskogo Stroeniya Metallov i Splavov. Svechnikov, V. N. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1966. (In Russian).

The magnitude of ML5 steel mechanical property changes depends on the integral neutron flux and on the state of the alloy. Neutron irradiation at 70°C of the alloy hardened in the T4 regime, and aged as a result of extended storage or use, leads to extensive decomposition of the solid solution with localized precipitation on the grain boundary with its subsequent insulation. Neutron irradiation at approximately 70°C impairs the stability of ML5. As the brittleness is increased the same radiation dose causes changes in the stability. Annealing of ML5 at increased temperatures after neutron irradiation starts restoration. (tr-auth)

8803 GAMMA RADIATION EFFECTS ON CERTAIN PROPERTIES OF FOUNDRY ALLOY ML5. Meshkov, V. N.; Konozenko, I. D. (Inst. of Physics, Kiev). pp 128-40 of Izuchenie Defektov Kristallicheskogo Stroeniya Metallov i Splavov. Svechnikov, V. N. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1966. (In Russian).

The magnitude of alloy ML5 mechanical property changes depends on the radiation conditions (temperature and integral gamma flux) and on the state of the steel. Gamma radiation at 20 ± 5 and 70 ± 5°C causes extensive decomposition of the solid solution with localized precipitation of metallic compounds at the grain boundaries causing solid solution isolation. The stability of ML5 deteriorates and the brittleness increases as results of the irradiation. The possibility of recovery of the mechanical properties after γ radiation by means of extended annealing at temperatures above 325°C exists. (tr-auth)

8804 IRRADIATION BEHAVIOR OF PLUTONIUM FUELS. Freshley, M. D. (Battelle Memorial Inst., Richland, Wash.). pp 643-706 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

The results of plutonium-containing fuel element irradiation test results to date are summarized and, to some extent, evaluated. The materials discussed include: Pu, Al–Pu, U–Pu, U–Pu–Mo, U–Pu–fizzium, Th–Pu, Zr–Pu, PuO_2, UO_2–PuO_2, ZrO_2–PuO_2, MgO–PuO_2, ThO_2–PuO_2, PuO_2-bearing glass fuels, PuO_2-impregnated graphite, PuC, PuC–UC, PuN, PuN–UN, and Pu-containing cermet fuels. (121 references). (P.C.H.)

Ceramics and Cermets

Refer to abstracts 8685–8687, 8689, and 9240.

Preparation and Fabrication

Refer also to abstracts 8061 and 8719.

8805 (CONF-670533-8) METALLOGRAPHIC EXAMINATION OF PLUTONIUM DIOXIDE MICROSPHERES. Kelly, M. D.; Tucker, P. A. (Mound Lab., Miamisburg, Ohio). [Dec. 21, 1967]. Contract AT(33-3)-Gen-53. 14p. Dep. CFSTI.

From 21st AEC Metallographic Group Meeting, Upton, N. Y.

The structural integrity of plasma-fired plutonium dioxide microspheres has been investigated by metallographic techniques. The microspheres are highly susceptible to edge rounding and brittle plucking during grinding and polishing. A technique is described which eliminates these problems. Cross-sectioned, polished and etched microspheres are illustrated. (auth)

8806 (ORNL-4170, pp 206-10) REACTOR EVALUATION. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

The potential of various reactor systems for commercial exploitation is analyzed by evaluation of fuel fabrication costs and fuel element performance for potential reactor systems. Development of the library of computer programs for estimating fuel fabrication costs to cover fast reactor fuels is expanding. These fuels present a unique problem in that the core fuel elements containing recycle plutonium require remote fabrication, while the radial and the axial blanket fuel contains depleted uranium, which can be fabricated in ventilated hoods. The evaluation of the Heavy-Water Organic-Cooled Reactor assessment of four alternative fuel-element designs from the standpoint of the cost of fuel fabrication and predicted performance continues. (auth)

8807 (WCAP-3791-10) URANIUM PLUTONIUM CARBIDE DEVELOPMENT. Quarterly Progress Report for the Period Ending September 30, 1967. Biancheria, A.; Bishop, E. C.; Jacoby, W. R. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Oct. 1967. Contract AT(30-1)-3791. 106p. Dep. CFSTI.

Progress is reported in the development of a basic fuel element design suitable for application in a commercial, liquid metal-cooled fast breeder reactor (LMFBR). The production of UC pellets continued. Procedures were revised when O content was found to be above specifications. New pellets were trial-loaded into stainless steel tubes followed by Na bonding. Characterization techniques were developed. End plug welding was completed and the weld qualification program was started. An eddy current test is being developed to determine voids in Na bonded fuel elements. The process, characterization, and inspection of fuel pins has been documented. Cladding studies continued and test apparatus for Na deposition studies was fabricated. Fuel capsules and thermal flux test pins are being fabricated. Shipping containers are being constructed. Post-irradiation examinations are being planned. Fast test flux pins are being redesigned for EBR-II operation. Fuel column height was increased to ~9.5 in. and provision made for inclusion of a vanadium alloy sample below each pin. (F.S.)

8808 STUDY OF THE CONDITIONS OF SINTERING OF LANTHANUM HEXABORIDE. Meerson, G. A.; Mamedov, F. G. (Moscow Inst. of Steel and Alloys). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 942-9(June 1967). (In Russian).

Sintering of high-purity LaB_6 powder of various grain sizes and of technical-grade LaB_6 powder was studied in a vacuum and in gaseous media (argon, hydrogen). The behavior of impurities and their effects on densification during sintering were also studied. LaB_6 samples of predetermined density up to the theoretical value or values close to it can be obtained by cold pressing of the pure powder followed by sintering in argon at 2000 to 2450°C or in hydrogen at 1800 to 2200°C. The insufficient purity of industrial LaB_6 and of LaB_6 used in earlier studies prevented densification during sintering because of the vaporization of impurities, and this gave rise to the erroneous notion that the sintering method is unsuited for the preparation of high-density LaB_6 articles, and that only hot pressing in graphite molds must be employed. It was found that vaporization of lanthanum takes place at 2000 to 2200°C in a vacuum together with the volatilization of the hexaboride. (ATD)

8809 USE OF THE VIBRATIONAL COMPACTION IN THE PRODUCTION OF CERAMIC FUEL ELEMENTS. Zivanovic, Branislav; Mikijelj, Vojin. Nukl. Energ., 3: No. 6, 8-12(1966). (In Serbo-Croatian).

The development, principles, and manufacture of vibratory compacted ceramic fuel elements are discussed. It was possible to produce vibratory compacted ceramic fuel elements at the desired level. The main obstacle to economical production of vibratory compacted fuel elements is the high cost of feed materials, e.g., fused UO_2. The broader possibilities of this method in the use of enriched fuel, especially PuO_2–UO_2, is underlined. The significance of this technique in the production of non-oxide ceramic fuel elements, such as uranium carbide, nitride, and sulfide, is emphasized. The possible use of sintered and crushed UO_2 as the feed material for vibratory compaction, and other possibilities of combining this technique with others, e.g., swaging, are considered. (M.C.G.)

8810 PLUTONIUM CERAMIC FUEL FABRICATION. Thomas, I. D. (Nuclear Materials and Equipment Corp., Apollo, Pa.). pp 619-41 of Plutonium Handbook. A Guide to the Technology. Vol. 2. Wick, O. J. (ed.). New York, Gordon and Breach, Science Publishers, 1967.

Fabrication schemes for plutonium oxide systems for use as a fuel for nuclear reactors are described. However, the same processes are generally applicable to the fabrication of the other plutonium ceramics, with modifications mainly in the ambient atmosphere and temperature requirements. The methods described include: pellet in tube process; vibrational compaction; and swage compaction. The fabrication and coating of spherical fuel particles is also discussed. (P.C.H.)

8811 EXTRUSION OF URANIUM OR A SIMILAR CARBIDE. Accary, A.; Magnier, P.; Marchal, M. (to Commissariat a l'Energie Atomique). Canadian Patent 767,985. Sept. 26, 1967. Priority date July 17, 1964, France.

A process is described for extruding carbides of U, Th, Pu, and W at temperatures of 1600 to 2400°C through graphite dies. Pressures up to 800 kg/cm^2 are used and the carbothermy is performed in a vacuum. The ratio of the cross sections of the pieces before and after extrusion varies from 2 to 10. Several methods are used for reducing or eliminating surface cracking because of too rapid cooling. (F.S.A.)

8812 IMPROVEMENTS IN OR RELATING TO OXIDE RESISTOR FURNACE ELEMENTS. Causer, Roy (to United Kingdom Atomic Energy Authority). British Patent 1,096,336. Dec. 29, 1967. Filed Aug. 2, 1965.

An oxide resistor furnace element is described that consists of a number of annular rings of a refractory metal oxide, such as zirconia-calcia or zirconia-yttria, arranged in an end-to-end relationship to form a tube. One end of each ring is provided with a counterbore and the other with a projecting conical surface extending at 30° to the diametrical plane of each ring. Each ring is formed by compressed powder prefired to 1550°C, machined and fired at 1850 to 1900°C, assembled as a tubular element, and sintered above 1850°C. (F.S.)

8813 HIGH DENSITY SINTERED CERAMICS. Steele, Bernard Robert; Rigby, Frank (to United Kingdom Atomic Energy Authority). British Patent 1,096,314. Dec. 29, 1967. Filed Mar. 19, 1964.

A method for producing beryllium oxide of fine particle size, e.g., with a surface area of 10 to 20 m^2/g is described. An aqueous solution of Be sulfate is concentrated by boiling to cause evaporation to the point of crystallization. The hot saturated solution is passed into a chilled and continuously cooled aqueous solution of alcohol where Be sulfate tetrahydrate crystals are produced by precipitation. The crystals are converted to Be sulfate dihydrate by heating under vacuum to a temperature such that only two of the molecules of water of crystallization are driven off. The Be sulfate dihydrate is then calcined in air to form beryllium oxide. (F.S.)

8814 METHOD FOR THE PRODUCTION OF CERAMIC NUCLEAR FUEL ELEMENTS. Hirose, Yasuo; Takeda, Seiji (to Hitachi, Ltd.). U. S. Patent 3,346,676. Oct. 28, 1964. Priority date Oct. 28, 1963, Japan.

A method is described for manufacturing metal clad nonsintered ceramic powder nuclear fuel elements of great density from a metallic cladding tube and ceramic nuclear fuel powder. The fuel is compacted by vibration in the tube. The inner parts of the cladding tube and the powder are subjected to evacuation during heating to a temperature below the sintering temperature of the fuel while concurrently compacting the powder by vibration. (F.S.)

8815 METHOD FOR PRODUCING A DISPERSED-IN-GRAPHITE NUCLEAR FUEL. Ishihara, Takehiko (to Japan Atomic Energy Research Inst.). Japanese Patent 1966-18799. Oct. 29, 1966. Filed Nov. 5, 1963.

The proposed method can be used to produce fuel elements with a uniform dispersion of fine uranium-oxide particles. Impermeability treatment and graphitization are achieved in a single process. A uranium salt is blended with a mixture of furfural alcohol and phenol, then concentrated hydrochloric acid is added as a dehydrogenation catalyst. The mixture is placed in a mold of a desired shape, where the condensation is carried out. After solidification, it is taken out of the mold, and hardened. The hardened material is carbonized by firing in an inert-gas atmosphere, in the first stage increasing the temperature to 500°C at the rate of less than 100°C per hour and in the second stage to 1200°C at less than 20°C per hour. The material is graphitized by heat-treating it above 2550°C in a non-oxidizing or reducing atmosphere for over one hour. The resultant product is an impermeable, dispersed-in-graphite uranium fuel of the desired shape. (NSA of Japan)

8816 FABRICATION OF GRIDS BY PNEUMATIC IMPACTION. (to United States Atomic Energy Commission). British Patent 1,097,266. Jan. 3, 1968. Priority date Feb. 19, 1965, United States.

A method is described for making grid type nuclear fuel elements from cermets such as compacted mixtures of metals with oxides of U, Pu, or both, or other fissionable ceramics such as carbides or nitrides of U or Pu or both. The grid type fuel elements are made by arranging a number of mandrels within a can spaced in relation to one another to form a mold. A cermet is placed in the spaces between the mandrels and the can. The cermet is confined to keep it from expanding. The cermet is heated to a temperature below the reaction temperature of the metal and ceramic. Force is applied at the ends of the cans and mandrels, and the cermet mixture in the direction of the length of the can compacting the ceramic powder by decreasing its dimension in the direction of the length of the mandrels and decreasing the thickness of its webs by increasing the thickness of the mandrels and can. Mandrels are removed by dissolution. (F.S.)

8817 PROCESS FOR THE PREPARATION OF NUCLEAR FUEL CARBIDES. Beucherie, P.; Payrissat, M.; Wurm, J. G. (to European Atomic Energy Community). Canadian Patent 767,556. Sept. 19, 1967. Priority date Sept. 1, 1964, Belgium.

The carbides of Pu, Th or U, particularly the latter are prepared by the reaction; $UF_4 + 4Al + 3C \rightarrow 3UC + 4AlF_3$. Other uranium halides may also be used. The starting materials with a 30−40% excess of Al are formed into tablets using a vacuum press in a glove box. Heating from 1200−1600°C in a graphite crucible is then required, first in an atmosphere of argon and later in vacuo to remove the excess Al and AlF_3 as vapour. The UC remaining has a low impurity content and will not ignite spontaneously in air. (F.S.A.)

Properties Evaluations

Refer also to abstracts 8040, 8724, 8751, 8762–8764, and 8847.

8818 (BMI-X-447) HOT-HARDNESS MEASUREMENTS OF ThO_2–UO_2 FUEL PELLETS (LWBR–LSBR DEVELOPMENT PROGRAM). Koester, Robert D.; Price, David E.; Moak, Donald P. (Battelle Memorial Inst., Columbus, Ohio). Aug. 1967. Contract AT-11-1-GEN-14; Subcontract 73-14-1242. 27p. Dep. CFSTI.

For Bettis Atomic Power Lab., Pittsburgh, Pa.

The plot of logarithm of hardness numbers versus temperature for ThO_2 behaves anomalously. The normal behavior for cubic structures is a change in slope of the hardness curve at approximately half the absolute melting point (T_m) of the material with an increase in negative slope. The change is from a glide process to a diffusion-controlled process. The decrease in negative slope which occurs at 0.47 T_m as exhibited by pure ThO_2 cannot be explained, but a similar behavior has been observed for ZrB_2[2]. The straight line observed for all the solid-solution oxides of $ThO_2 - UO_2$ suggests that a change in mechanism does not occur at 1000 to 1800°C. One half the absolute melting point for ThO_2 is approximately 1500°C. The additions of UO_2 to ThO_2 greater than 1.5 wt % increased the hardness of ThO_2 at all temperatures. The hardness of the ThO_2 + 1.5 wt % UO_2 composition is lower than any other composition including the pure ThO_2. The porosity distribution of the 1.5 wt % alloy appears to be the cause of its low hardness even though the density measurements do not indicate any undue variations. Another unknown factor is that slight grain size variation may occur from composition to composition and cause some anomalies. A plot of hardness at various temperatures versus composition is given. The 6 wt % additions of UO_2 results in the greatest increase in hardness at 1000°C of any of the compositions, while the 1800°C data for this composition are very close to that of pure ThO_2. The 13, 20, and 30 wt % additions of UO_2, while not possessing higher hardnesses than the 6 wt % UO_2 composition at 1000°C, do have progressively higher hardnesses than ThO_2 and ThO_2 + 6 wt % UO_2 at 1800°C. The change-over temperature from higher hardness for the 6 wt % UO_2 composition to higher hardness for the higher compositions is 1300°C. It appears that the strongest compositions for use in the 1000°C temperature range are the ones with approximately 6 wt % UO_2 addition. However, for the 1800°C temperature range the compositions with larger additions of UO_2 are strongest. The 13 wt % UO_2 composition is the only one that exhibits uniformly higher hardnesses than ThO_2 at 1000°C through 1800°C. (auth)

8819 (KAPL-P-3395) PRECIPITATION, FRACTURE, AND HARDNESS IN UO_2 AND UO_2–ZrO_2. Forlano, R. J.; Alberts, A. H.; Proebstle, R. A. (Knolls Atomic Power Lab., Schenectady, N. Y.). [1966]. Contract W-31-109-eng-52. 31p. Dep. CFSTI.

From Nuclear Division Fall Meeting, Urbana, Ill.

Precipitation in UO_2−23 mole % ZrO_2 is of a discontinuous type. Recrystallization apparently accompanies precipitation and causes grain refinement of the microstructure. The mode of fracture in the compositions studied was mainly transgranular by cleavage. Heat treatment, inducing precipitation, results in a fracture pattern that is still transgranular by cleavage but with a coarser and rougher appearance. No evidence of brittle ductile transition was found up to 800°C. Addition of ZrO_2 increased the hardness in the $UO_2 - ZrO_2$ system. The hardness decreased with higher porosity or testing temperature. The effect of porosity was greater at low temperatures than at high temperatures. (auth)

8820 (ORNL-4170, pp 32-3) FUNDAMENTAL CERAMICS RESEARCH. Fulkerson, W. (Oak Ridge National Lab., Tenn.).

Research on uranium nitride, which will include single-crystal fabrication, band-theory calculations, physical-property measurements, deformation mechanism studies, solid-state diffusion studies, low-temperature specific heat measurements, helium bubble migration in a thermal gradient, and surface reaction studies is discussed. It is a nuclear ceramic refractory hard metal. (auth)

8821 (ORNL-4170, pp 34-6) PHYSICAL CERAMICS STUDIES. Morgan, C. S. (Oak Ridge National Lab., Tenn.).

The effect of isostatic pressing on subsequent sintering of partially sintered oxide powder compacts suggests a dislocation contribution to the material transport processes. Results of topological studies of sintering copper powder compacts indicated that the void space does not undergo spheroidization until approximately 99% of the theoretical density is attained. Deformation mechanics in UO_2 single crystals under compression are being analyzed. Specimens of sintered ThO_2 sol-gel powder underwent extensive grain-boundary sliding in compressive creep. (auth)

8822 (ORNL-4170, pp 163-72) GAS-COOLED REACTOR PROGRAM. Coobs, J. H. (Oak Ridge National Lab., Tenn.).

All-ceramic nuclear fuels consisting of pyrolytic-carbon-coated $(Th,U)O_2$ and $(Th,U)C_2$ fuel particles offer advantages as fission-product-retaining fuel for high-temperature gas-cooled reactors. The techniques for fluidized-bed coating of particles and the testing of coating materials and coated-particle fuels are advanced. The desirable high-density isotropic coatings could be deposited at very high rates at low temperatures using propane or propylene as reactant. Oxide fuel particles having this type of coating survived heat treatment up to 2600°C, but thermal creep from the high internal carbon monoxide pressure caused large dimensional changes and increases in anisotropy. Techniques for fluidized-bed deposition of SiC coatings on fuel particles are listed. Mathematical analysis of stresses in coatings were also extended to include creep, which may significantly extend the life of isotropic pyrolytic carbon coatings under high exposures to fast neutrons. Density and dimensional changes in pyrolytic carbon irradiated to a high fast-neutron dose demonstrated the stability of isotropic structures and indicated that densification is a first-order rate process. Irradiation tests on coated-particle fuels demonstrated that the low-temperature isotropic coatings would withstand high fuel burnup and confirmed our previous favorable observations on the irradiation stability of coated sol-gel oxide fuels. (auth)

8823 (ORNL-4170, pp 211-26) THORIUM UTILIZATION. Lotts, A. L. (Oak Ridge National Lab., Tenn.).

A program to demonstrate the refabrication of high-temperature gas-cooled reactor fuel elements in the Thorium-Uranium Recycle Facility (TURF), a facility for demonstration of pilot-scale processes is described. Remotely operated processes and equipment to refabricate fueled-graphite elements are being developed. A variety of devices for handling a large number of particles and batches of particles simultaneously was developed. These developments include a pneumatic fuel transfer system, a high-efficiency shape separation process, a classification process to grade uncoated and coated fuel particles within ±5 μ with a minimum of screen blinding, and suitable valves and feeder mechanisms to serve the various pieces of the particle-handling system. A reliable engineering-scale particle-coating system was selected, namely, a 5-in. fluidized bed. Over 400 experimental coating runs were made to define the coating parameters for the system. A process was developed to produce low-density buffer coatings from acetylene on bare 230-μ-dia particles with controlled density from

0.4 to 1.4 g/cm^3. A technique was developed for applying high-density (approximately 1.9 g/cm^3) isotropic outer coatings by the pyrolysis of propane and propylene at 1200 to 1500°C at coating rates up to 3 μ/min. A faster and more accurate technique for obtaining the density, anisotropy, and thickness of pyrolytic carbon coatings, and techniques for determination of the diameter of bare particles were developed. The blending of two sizes of fuel particles, one for coated fissile and one for fertile fuel particles, was investigated. These must be homogeneously blended and bonded in fuel holes to a packing density of 60 to 64 vol % and then filled with a carbonaceous binder. After checking the conventional techniques for blending particles, equipment for blending particles by controlling the feed rates of the two different-size particles as they flowed simultaneously from separate feed hoppers into a simulated fuel hole was designed. The maximum deviation from the ideal blend was less than 5%. Various filler materials and resins for obtaining the bond between the coated particles were studied, principally to decrease the period of time required for polymerization of the resin. Work to nondestructively determine the homogeneity of fabricated fuel sticks, using through-transmission x-ray methods to detect density differences caused by differences in the packing of two sizes of particles was started. The results of irradiation tests continue to indicate that the sol-gel-prepared oxide fuels perform equivalently to ceramics processed by other methods. A particle-performance model that is designed to predict the lifetime of fuel particles operating at certain conditions was tested against actual irradiation experience; it has proved most helpful in the design of coated particles. Sol-gel techniques provide high flexibility in the forming of ceramic bodies. Sol-gel-derived materials to produce bodies without plasticizers and with controlled densities in the range from 75 to 99% of theoretical were extruded. In laboratory-scale work solid and cored thoria extrusions in diameters up to ½ in. and lengths to 3 in. were produced. The feasibility of pelletizing sol-gel-derived materials to sintered densities as high as 97% of theoretical at relatively low temperatures (1100°C) was demonstrated. Sphere-Pac fabrication (the use of low-energy vibratory compaction and two size fractions of microspheres) was further demonstrated by the fabrication of 33 test rods ranging in dia from ¼ to ½ in. and lengths up to 2 ft. These rods packed to a density of 83.5 ± 0.5%. The irradiation testing and evaluation of metal-clad thoria-base bulk oxide fuels continued. Thoria-base fuels have been irradiated to a burnup of 150,000 MWd/tonne with a linear heat rating of 400 W/cm. Successful tests have been completed with heat ratings of 1000 W/cm. All of the thoria under test continues to exhibit exceptional performance characteristics. The basic study of the sintering and grain growth of sol-gel urania microspheres led to a drying and sintering schedule that, on a laboratory scale, yielded microspheres of high density and low residual carbon content. (auth)

8824 (ORNL-TM-2016) HELIUM GAS BUBBLE MIGRATION IN URANIUM MONONITRIDE IN A TEMPERATURE GRADIENT. Weaver, Samuel Cavin (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 104p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

Helium bubble migration in uranium mononitride was studied at 985 to 1585°C with temperature gradients ranging from 75 to 880°C per centimeter. The UN specimens were inoculated with 250-keV helium ions from a Cockcroft-Walton accelerator. Both the temperature and temperature gradients were known accurately and could be controlled. The migration distances and bubble sizes were examined by replication electron microscopy applied to longitudinal sections (parallel to the temperature gradient) through the UN specimens. Thin-film transmission and replicas of fractured surfaces were used to support the results obtained from the longitudinal sections. The bubbles were observed to migrate by surface diffusion up the temperature gradient at velocities ranging from 300 angstroms per second at 985°C to greater than 11,000 angstroms per second at 1585°C. From measurements of the migration distances, an approximate surface diffusion coefficient, D_s, for UN was calculated to be: $D_s = 1.92 \times 10^3 \exp(-42{,}200/RT)$ square centimeters per second. Although the bubbles migrated large distances, they were not observed to coalesce during the heat treatments. It is suggested that this behavior was caused by the existence of large stress fields in the UN matrix surrounding the bubbles which caused the bubbles to repel each other. These stress fields were presumably caused by high nonequilibrium internal pressures in the gas bubbles. (auth)

8825 (UCID-15238(Pt.1)) CONTRIBUTION TO THE 25TH MEETING OF THE HIGH-TEMPERATURE FUELS COMMITTEE, DECEMBER 5-7, 1967, AT GENERAL ATOMIC, SAN DIEGO, CALIFORNIA. Rothman, A. J. (comp.) (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 25, 1967. Contract W-7405-eng-48. 31p. (CONF-671206-1). Dep. CFSTI.

From 25th Meeting of the High Temperature Fuels Conference, San Diego, Calif.

Uranium nitride heated in nitrogen at 1950°C and at an estimated pressure of 20 atm for 24 hours showed anomalously large grain growth. The technique was used to grow large single crystals, but the results were not reproducible from sample to sample. The diffusion coefficient of nitrogen in uranium nitride appears to decrease appreciably with decreasing nitrogen pressure. About a five-fold reduction in the diffusion coefficient results from a change in nitrogen pressure from 110 to 7 torr. A capsule to irradiate uranium nitride having various microstructures at 1500°C is being fabricated. Calculations have been made for nitrogen balances in fissioning uranium nitride at various temperatures and nitrogen pressures. About 17 atoms of free nitrogen become available for each 100 atoms of uranium fissioned under most conditions at 1500 to 2500°K, and various nitrogen pressures from 10^{-6} to 1 atm. Improved solubility measurements of tungsten in liquid silver are 1.2 ppM at 2380°C, and 0.7 ppM at 2200°C. (auth)

8826 FRICTION AND WEAR OF MATERIALS IN SLIDING CONTACT FROM ROOM TEMPERATURE TO 1200 F IN LIQUID POTASSIUM AND IN HIGH VACUUM (10^{-9} TORR). Moor, Bluford L.; Frank, Robert G. (General Electric Co., Cincinnati). pp 462-91 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5-7, 1967. See CONF-670601.

A materials evaluation program was conducted to identify materials suitable for use in potassium lubricated journal bearings over a temperature range of 400 to 1600°F. Two hemispherical pin-rotating disc test rigs were designed and constructed to evaluate the friction and wear behavior of selected material combinations under conditions of no lubrication in high vacuum (10^{-9} torr) and under boundary lubrication with liquid potassium. Based on compatibility tests in potassium contained in Nb-1Zr alloy capsules, dimensional stability, strength and hardness and wettability by potassium, the refractory metal bonded carbides TiC + 10% Nb and Grade 7178 and the commercial cobalt bonded carbide Carboloy 907 materials have demonstrated excellent potential for use in potassium lubricated bearing applications. Results of the friction and wear tests have indicated superior performance of the self-loaded hard-hard combinations of the above three materials over hard-soft combinations of the same materials with Mo-TZM alloy as the stationary bearing material. Lower friction and wear coefficients were obtained and higher load carrying capabilities were possible with the hard-hard combinations under conditions of boundary lubrication and no lubrication. (auth)

8827 EFFECT OF RADIATION AND ADDITIVES ON GRAPHITE LUBRICANTS FOR HIGH TEMPERATURE APPLICATIONS. Lipp, L. C.; Stern, H. (Washington State Univ., Pullman). pp 288-303 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5-7, 1967. See CONF-670601.

The effect of neutron radiation, additives, and 1500°F prefiring on the lubrication properties of graphite-inorganic halide combinations were studied through the 100 to 1500 F temperature range, with particular emphasis placed on temperatures above 1000°F. It was found that regardless of radiation, when a graphite-$CrCl_3$ mixture was prefired at 1500°F in a container which limited the access of oxygen significant improvements in friction and wear properties of the lubricant were obtained (coefficient of friction remained below 0.10 from 100 to 1500°F). This result suggests the possible formation of an intercalated compound of graphite with $CrCl_3$ which produces a temperature stable lubricant. Friction and wear characteristics of the radiated graphite mixed with B_2O_3, LiF, $(PNCl_2)_3$, AgCl, and $CrCl_3$ were evaluated and compared with unirradiated samples. No major changes were found in the overall performance of these lubricants after the radiation exposures up to 10^{16} nvt. One lubricant (graphite-$CrCl_3$) indicated a possible trend of improved friction characteristics with increasing irradiation dosage of the graphite. Others showed slight deleterious effects. (auth)

8828 COHESION IN CUBIC REFRACTORY MONOCARBIDES, MONONITRIDES, AND MONOXIDES. Denker, S. P. (Columbia Univ., New York). J. Less-Common Metals, 14: 1-22(1968).

The coincidence of high-temperature strength and metallic electrical conductivity suggests an admixture of covalent and metallic bonding. Previously the simple application of these models has led to apparently antithetical explanations of material properties. In refractory compounds, several kinds of binding must exist. It is possible to assume that although different bonding mechanisms are operative, there are continuous transitions from one dominant bond type to another, corresponding to the situation encountered in the modern theory of alloys. The intrinsic mechanical, chemical, and electrical properties as observed experimentally, are related to the valence electron concentration. The electronic band structure is described in terms of electronic molecular orbitals (taken as a linear combination of atomic orbitals) involved in cation–cation and cation–anion interactions. The degree of anion and cation interaction can be largely described by the overlap integrals associated with clusters of atomic orbitals. Thus properties which characterize and stabilize in these compounds can be related to the average valence electron concentration per molecule, MX, and thereby directly to the atomic orbitals. Maximum stability or optimum binding energy, characterized by properties such as maximum melting point and low vaporization rate at high temperatures, is achieved by that crystal structure in which nearly all the bonding orbitals are occupied and antibonding orbitals vacant. Since in the solid, energy states derived from both types of interactions broaden into bands and overlie each other in energy, maximum stability occurs for a valence electron concentration (V.E.C.) between 8 and 9 valence electrons per molecule. (auth)

8829 CERTAIN OPTICAL AND PHYSICAL PROPERTIES OF SYNTHETIC URANITITE. Osipov, B. S. Dokl. Akad. Nauk SSSR, 176: 672-5(Sept. 21, 1967). (In Russian).

The data on properties of uranium dioxide synthesized at high temperature by calcination sublimation of pressed UO_2 or $UO_2(OH)_2$ powders in hydrogen atmosphere or by electrolysis of UO_2Cl_2 in chloride melts were obtained previously. The data obtained are compared with the properties of natural uranium oxides developed mainly by hydrothermal processes. The results indicated that microhardness, reflection, and lattice parameters of UO_2 are interrelated and the regular variations of these properties are determined by the magnitude of the oxygen coefficient. The smaller the ratio O/U the larger the lattice parameter of UO_2 and the smaller the microhardness and reflectivity of UO_2 specimens produced at constant temperature. (R.V.J.)

8830 PARTICLE PROPERTIES AND SINTERING BEHAVIOR OF URANIUM DIOXIDE. Cordfunke, E. H. P. (Reactor Centrum Nederland, Petten, Netherlands); Van Der Giessen, A. A. J. Nucl. Mater., 24: 141-9(1967).

The sintering behavior of UO_2 has been studied as a function of its preparation conditions, using oxide powders of widely differing morphology. The variables studied are mainly particle size and shape, the calcination temperature, and the sinter atmosphere. Their effects on compacting density and sinter density are shown and discussed. (auth)

8831 SOME DATA ON THE OXIDIZABILITY OF BORON NITRIDE AT HIGH TEMPERATURES. Pechentkovskaya, L. E.; Dubovik, T. V.; Nazarchuk, T. N. (Inst. of Materials Science Problems, Kiev). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 963-6(June 1967). (In Russian).

The effects of the temperature of preliminary firing of boron nitride powder in a stream of nitrogen at 1600 to 2400°C on its stability in oxygen were determined. Chemical and x-ray diffraction analyses were employed. The oxidation resistance in oxygen was found to increase and approach the stability of hot-pressed samples as the temperature of preliminary firing in nitrogen was raised, and became greatest when the firing temperature was 2200 to 2400°C, due to a decrease of the specific surface of the powder during the firing. Firing of boron nitride at 2200 to 2400°C is recommended as a method of raising the resistance of this compound against oxidation when it is used as a powder in high-temperature technology. (ATD)

8832 EFFECT OF CHEMICAL BONDING ON THE LUMINESCENCE OF URANYL IN GLASSES. Zhabotinskii, M. E.; Rudnitskii, Yu. P.; Tsapkin, V. V.; Tsapkina, I. V.; Ellert, G. V. (Inst. of Radio Electronics, Novosibirsk, USSR. Inst. of General and Inorganic Chemistry, Novosibirsk, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1007-11(June 1967). (In Russian).

The luminescence and absorption spectra and the lifetimes of uranyl were measured in glasses whose initial composition included $K_2[UO_2(SO_4)_2]$, B_2O_3, and various fluorinating agents, particularly KBF_4. Analysis of the luminescence data suggests that in fluorinated glasses during vitrification, uranyl ions first form insular structures isolated from the remainder of the glasses. As the uranyl concentration rises and the fluorinating agent becomes depleted, centers of other types also are formed. It is shown that the formation of insular-type uranyl compounds considerably weakens the bond between uranyl and the glass matrix and the bond with the phonon field; this shows up in a shift of the absorption spectra, in a weak temperature dependence of the quantum yield of luminescence in the fluorinated glasses, and in a decrease of the energy exchange between uranyl centers. A change in the principal chemical bonds of the active centers appears to have a pronounced effect on the luminescent characteristics of the glasses. This may also be the case with other matrices and ions, particularly ions with valence 3f and 4f valence subshells. 5 figures, 1 table and 2 formulas. (ATD)

8833 MAGNETIC PROPERTIES OF NEODYMIUM TELLURIDES. Pechennikov, A. V.; Chechernikov, V. I.; Yarembash, E. I.; Zinchenko, K. A. (Moscow State Univ. Inst. of General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1086-7(June 1967). (In Russian).

The temperature dependence of magnetic properties of NdTe, Nd_2Te_3, Nd_4Te_7, $NdTe_2$, $NdTe_3$, and $NdTe_3$ was analyzed. (R.V.J.)

8834 PREPARATION OF PURE YTTRIUM HEXABORIDE AND STUDY OF ITS EMISSIVE PROPERTIES. Ermakov, S. V.; Mamedov, F. G.; Meerson, G. A.; Tsarev, B. M. (Moscow Inst. of Steel and Alloys). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1094-5(June 1967). (In Russian).

High-purity yttrium hexaboride of stoichiometric composition was prepared by the reaction $Y_2O_3 + 15B \rightarrow 2YB_6 + 3/2B_2O_3$, and the emissive properties of its powder, deposited on a tungsten ribbon, were studied. The effective work function was found to vary linearly with the temperature over the entire range of cathode temperatures and to obey the equation $\phi_{eff} = (2.78 + 2.075 \times 10^{-4}\ T)$, eV. In contrast to previous findings, it was established that the work function of YB_6 is higher than that of LaB_6. The data obtained are close to previous data where YB_6 was tested on a tantalum support. (ATD)

8835 OXIDATION OF URANIUM DIOXIDE ON HEATING IN AIR. Bessonov, A. F.; Taksis, G. A.; Semavin, Yu. N. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1104-6(June 1967). (In Russian).

The oxidation of uranium dioxide was studied by means of a high-temperature apparatus which made it possible to record an x-ray diffraction pattern, an electrical resistivity curve, a curve of the change of linear dimensions, and a thermogram simultaneously and on the same sample. The data obtained indicate the mechanism of oxidation of uranium dioxide on heating in air. During the initial stages of oxidation, a coherent rearrangement of the lattice involving an extensive orientational-dimensional correspondence takes place, no changes in the specific surface or unit cells of the oxides (oxidation products of the powdered dioxide) being observed. The inter-phase stresses are therefore insufficient to disrupt the continuity of the crystal aggregates. The contract area between the particles and the surface conductance do not change either, and all the resistivity changes occur in the cells of the oxides. For this reason, the phase transitions are associated with breaks on the resistivity curve. The transformation of the tetragonal phase into the orthorhombic U_3O_8 involves the formation of nuclei of a new phase and their further growth, and is associated with a considerable increase of the specific surface of the oxide, resulting in a change of the contact area between the particles. The conductance of the new phase is lower than that of the old phase, so that the resistivity curve shows an upward trend. (ATD)

8836 INTERNAL FRICTION OF GRAPHITES. Merlin, J. (Institut National des Sciences Appliquees, Lyon); Gobin, P.; Jouquet, G.; Rappeneau, J. J. Nucl. Mater., 24: 300-9(Dec. 1967). (In French).

The internal friction of graphites prepared by various processes was measured using a torsion pendulum (frequency of about 1 hertz) at room temperature. The damping coefficient δ depends on the amplitude in the relative deformation internal between 10^{-5} and about 10^{-3}. For a given deformation, this coefficient increases with increasing tendency of the graphite towards the monocrystalline form. An attempt to check the Granato-Lücke model that interprets the variations of internal friction with amplitude, was not conclusive. On the other hand, it was possible to establish a relationship with the conventional mechanical tests (tensile, bending, compression and torsion tests): the theoretical internal friction coefficient was calculated using Jenkins' equations describing the force-deformation curves for the graphite. The theoretical expression found corresponds to the general form of the changes observed experimentally. The studies carried out on nuclear graphite showed however that the theoretical damping coefficient is slightly higher than the experimentally obtained values. This is attributed to a phenomenon by which the graphite adapts itself to the cyclic treatment. (auth)

8837 PLUTONIUM DISTRIBUTION IN MOLTEN $(U, Pu)O_2$ FUELS. Muehling, G. (Kernforschungszentrum, Karlsruhe, Ger.); Stoll, W.; Theisen, R. J. Nucl. Mater., 24: 323-7(Dec. 1967). (In German).

Mixed oxides of plutonium and uranium can be melted by a method developed for pure uranium dioxide, involving dc heating under inert gas on a technologically useful scale. The solid solution thus produced is homogeneous at least to the resolution limit of the method of investigation used, i.e. 1 μm. The melting technique may therefore come to be of considerable importance for the production of very dense oxide starting material, and therefore for the production of nuclear fuels by the vibratory process. (auth)

8838 MELTING TEMPERATURES IN THE SYSTEM URANIUM–URANIUM DIOXIDE. Bannister, M. J. (Australia Atomic Energy Commission Research Establishment, New South Wales). J. Nucl. Mater., 24: 340-2(Dec. 1967).

Liquidus temperatures were measured by heating small chips of the U–UO_2 system until complete melting was observed. Solidus temperatures were determined in two different ways. A monotectic temperature of 2420 ± 70°C was found. The melting point of UO_2 was 2860 ± 70°C. The UO_2 was observed to be far more volatile at its melting point than any of the phases in the system. (M.C.G.)

8839 THE ELECTRICAL CONDUCTIVITY OF BeO AND BeO BINARIES. Bradhurst, D. H.; de Bruin, H. J. (Australian Atomic Energy Commission Research Establishment, New South Wales). J. Nucl. Mater., 24: 261-9(Dec. 1967).

The electric conductivity of pure BeO and its binaries with iron and aluminum was measured by a four-probe dc technique at 1000 to 1500°C. The activation energy for the electric conductivity was close to that for the self-diffusion of beryllium in BeO. Additions of iron and aluminum caused the conductivity to increase, but the activation energy remained unchanged. Polarization effects were observed. The results suggest that electric conduction in BeO is ionic in nature and impurity-controlled. (auth)

Structure and Phase Studies

Refer also to abstracts 8021, 8061, and 8847.

8840 (ORNL–4170, pp 3-7) CRYSTAL PHYSICS. Clark, G. W. (Oak Ridge National Lab., Tenn.).

The internal centrifugal zone-growth (ICZG) technique developed to grow crystals of UO_2 was improved. In the UO_2-tungsten cermet, both rod and lamellar eutectic structures resulted from the unidirectional solidification inherent in ICZG technique. Molten-salt growth of 2-mm ThO_2 single crystals doped with ^{244}Cm was accomplished; electron-spin resonance and optical-spectra studies are in progress. Hydrothermally, YOOH (up to 2 mm) was grown from LiOH solvent and doped with various Ln^{3+} ions. Crystals of iron (^7Li) ferrite and other ferrites up to 1 cm in dia and 8 cm long were grown. Good-quality oriented crystals resulted—as judged by neutron-rocking curve-line widths of 0.3° and straight sharp neutron Laue diffraction lines. The temperature dependence of the magnetic susceptibility and magnetization of small samples was measured. (auth)

8841 EFFECT OF THE PHASE COMPOSITION OF ZIRCONIUM DIOXIDE ON ITS THERMAL STABILITY. Karaulov, A. G.; Grebenyuk, A. A.; Rudyak, I. N. (Ukrainian Scientific Research Inst. of Refractories, Kharkov). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1101-3(June 1967). (In Russian).

Systematic studies of ZrO_2 were made in order to determine the quantity of monoclinic phase which provides for the highest thermal stability and to identify the factors responsible for this stability. ZrO_2 was stabilized by introducing $CaCO_3$ in amounts of 8 to 12 mole % and firing the briquet (mixture of ZrO_2 and $CaCO_3$) at 1750°C for 18 hr. The material obtained (which contained no more than 30% of the monoclinic phase) was then pulverized and used to prepare samples into which additional amounts of monoclinic ZrO_2 was introduced in order to modify their phase composition. The samples were then pressed (1000 kg/cm²) and fired at 1750°C for 6 hr. Determination of the thermal stability showed a maximum corresponding to a content of 20 to 40% of the monoclinic phase. The thermal stability is correlated with the microstructure of the samples. The increase in thermal stability with rising content of the monoclinic phase causes the coefficient of thermal expansion to decrease from (15×10^{-6}) to $(2.5-7.5)\ 10^{-6}\ deg^{-1}$ at 25 to 900°C and the elastic modulus to decrease from 3.5×10^5 to 0.8 to 0.9×10^5 kg/cm². In the 1000 to 2000°C range, the coefficient of thermal expansion of ZrO_2 samples increases. Marked changes causing a decrease of the strength and thermal stability of ZrO_2 occur only when the content of the monoclinic phase exceeds 40%. (ATD)

8842 COMPOUNDS OF UTe_5 IN U–Te SYSTEM. Slovyanskikh, V. K.; Ellert, G. V.; Yarembash, E. I. (Inst. of General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 1088-90(June 1967). (In Russian).

Differential-thermal and x-ray analyses of U–Te system indicated the possibility of formation of chemical compounds with stoichiometric composition of UTe_3, UTe_5, U_3Te_7, and also U_4Te_7. A phase diagram was constructed for the system of U–Te with 77 to 100 at. % Te. The results of the x-ray and phase analyses are tabulated and the temperature dependence curve of magnetic susceptibility of UTe_5 is shown. (R.V.J.)

8843 PREPARATION OF PURE RARE EARTH AND ALKALINE EARTH HEXABORIDES AND THEIR STUDY BY X-RAY DIFFRACTION. Mamedov, F. G.; Meerson, G. A.; Zhuravlev, N. N.; Umanskii, Ya. S. (Moscow Inst. of Steel and Alloys). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 950-6 (June 1967). (In Russian).

The preparation and lattice constants of pure hexaborides of lanthanum, yttrium, and alkaline earth metals were investigated. Pure LaB_6, YB_6, CaB_6, SrB_6, and BaB_6 of stoichiometric composition were obtained, and their lattice constants were found to be 4.1566, 4.102, 4.153, 4.198 and 4.268 Å respectively. The binary hexaboride $Ba_{0.64}Sr_{0.36}B_6$ with a lattice constant of 4.217 Å and the ternary hexaboride $Ba_{0.62}Sr_{0.33}Ca_{0.05}B_6$ with a lattice constant of 4.211 Å were also prepared. Precise measurements of the lattice constants of lanthanum boride with various contents of La and B near the LaB_6 composition refuted the hypothesis of the existence of a region of homogeneity based on LaB_6. (ATD)

8844 EFFECT OF PRESSURE ON THE FERMI SURFACE OF GRAPHITE. Anderson, J. R. (Sandia Lab., Albuquerque, N. Mex.); O'Sullivan, W. J.; Schirber, J. E.; Soule, D. E. Phys. Rev., 164: 1038-42(Dec. 15, 1967).

Measurements of the de Haas–van Alphen effect in natural single-crystal graphite have been made at pressures up to 4 kbar. The results for the majority carriers have been interpreted in terms of the Slonczewski–Weiss band model. The minority-carrier results appear to be consistent with the interpretation given by Dresselhaus and Dresselhaus in which spin-orbit splitting at the hexagonal zone faces is included. (auth)

Radiation Effects

Refer also to abstracts 8627, 8789, 8804, and 8807.

8845 (EURFNR–423) IRRADIATION PERFORMANCE OF FAST REACTOR FUELS. Geithoff, D.; Karsten, G.; Kummerer, K. (Kernforschungszentrum, Karlsruhe (West Germany)). Oct. 1967. 26p. (KFK–662; EUR–3698; CONF-671005–6). Dep.

Work performed under United States–Euratom Fast Reactor Exchange Program.

From Nuclear Metallurgy Conference, Phoenix, Ariz.

The requirements for uranium–plutonium dioxide fuels are the basis for a program of irradiation tests. The experimental facilities and irradiation devices are described and discussed with respect to the irradiation characteristics. The hot cell equipment provides for the standard examination technique including x-raying by betatron and fission gas chromatography. Short term behavior and long time behavior of oxide fuel pins are studied. Different pins have been irradiated in capsules and in a helium loop. Results indicate that the basic assumptions for the pin design are principally confirmed, the specimen failures arising from malfunctions of the irradiation devices. The now available irradiation experience is used for the fabrication of further irradiation specimens of more realistic fast reactor dimensions and also for the concept of fast breeder pin specifications. The main experiments are discussed. Finally the status of knowledge and experimental experience is composed in a set of conclusive remarks. (auth)

8846 (GA–7997) IRRADIATION TEST AND POSTIRRADIATION EXAMINATION OF THE GAIL IV FUEL ELEMENT IN THE GENERAL ATOMIC IN PILE-LOOP. Winkler, E. O.; Luby, C. S.; Scheffel, W. J.; Snow, B. D. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 30, 1967. Contract AT(04-3)-167. 190p. Dep. CFSTI.

The GAIL IV fuel element irradiation test was designed to obtain confirmatory information on the thermal, mechanical, and fission product release characteristics of an HTGR prototype advanced fuel element. The fuel element consisted of a twelve-hole telephone-dial-geometry graphite body containing Triplex pyrolytic-carbon-coated fuel particles packed loose in the holes. The element was irradiated in the In-pile Loop (GAIL) Facility at full power for over 9700 hours while generating a total of 670.6 MW-hr of energy. The observed in-pile fission gas release was very low (e.g., final ^{133}Xe and ^{88}Kr release rates were approximately 2×10^{-5}). The fuel was irradiated to an estimated maximum burnup of 5.9% fissions per initial metal atom (FIMA) at estimated temperatures of 950 to 1650°C. The calculated fast neutron dose was 7×10^{20} nvt (E > 0.18 MeV). The packed bed fuel element design operated very satisfactorily. The Triplex coated fuel particles were in good condition, good in-pile fission gas retention was achieved despite a few (~0.8%) broken fuel particles, and all metal and graphite components were in good condition. (auth)

8847 (NUMEC-3524-37) DEVELOPMENT AND TESTING OF PuO_2-UO_2 FAST REACTOR FUELS. Progress Report, January 1–March 31, 1967. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Oct. 1967. Contract AT(30-1)-3524. 29p. Dep. CFSTI.

For LMFBR mixed oxide density control, ceramic grade UO_2-PuO_2 fuel powder was pressed 20 to 100 kpsi then granulated and sized into 3 fractions. The sized granules were pressed into pellets with green densities in the range 45 to 60% T.D. Green pellets were sintered. Microstructures are shown. Low green densities, highest slugging pressures, and restricted granule size range produced the greatest density change. When pellet pressing pressure approached or exceeded slugging pressure, there was little or no effect on sintered density. The ratio of open to closed porosity increased with an increase in slugging pressure and decreased with an increase in green density. Autoradiographs of the fuel being irradiated in the EBR-II are shown. Some PuO_2 segregation is apparent due most likely to in-box contamination. Results of initial sintering trials with cp-UO_2 – PuO_2 as the matrix material and PuO_2 microspheres indicated that further refinements in the mixing and sintering cycles are needed. Results of the gravimetric analyses are given. Development work involving the determination of Zr as an impurity in UO_2 – PuO_2 is complete. Best results were obtained using a carrier method and barium fluoride mixed with graphite as the carrier. Procedures are described. (F.S.)

Plastics and Other Materials

Refer also to abstracts 8627 and 8685.

8848 (AEC-tr-6920) RADIATION EFFECTS ON POLYMERS. Van de Voorde, Marcel. Translated from Ind. At., No. 3/4, 61-70(1967). 16p. Dep. CFSTI.

The effects of nuclear radiation on polymers, as well as its influence on their chemical, mechanical, electrical, and optical properties, were examined. Applications in the field of accelerators are given, in particular for vacuum chambers and insulators. The damages currently caused by radiation in the CERN proton synchrotron and those that may be anticipated in the future are described. (auth)

8849 EFFECTS OF REACTOR RADIATION ON MIXED 5P4E USED AS A LUBRICANT IN A HIGH-SPEED, HIGH-TEMPERATURE BEARING-RIG. Laney, W. M.; McDaniel, R. H.; Lewis, J. H. (General Dynamics, Fort Worth, Tex.). pp 304-19 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

A radiation effects study has been conducted on mix-bis (mixphenoxyphenoxy) benzene–Mixed 5P4E–used as a high-speed bearing lubricant at elevated temperatures. This study employed a modified Shell high-speed, high-temperature, ball-bearing rig and the Ground Test Reactor. Bearing and bulk-oil test temperatures of 550, 600, and 700°F were employed with axial bearing load of 200 lb at 60,000 rpm during control and test runs. It was concluded that a gamma dose of 2×10^{10} ergs/gm(C) plus associated neutrons is approaching the useful upper limit for Mixed 5P4E as a high-speed lubricant in an oxidizing environment at temperatures of from 550 to 600°F. At 700°F this limit is decreased by approximately one order of magnitude. (auth)

8850 IRRADIATION EFFECTS ON BONDED LUBRICANT FILMS AND CONSTITUENT LUBRICATING SOLIDS. McConnell, B. D. (Wright-Patterson AFB, Ohio); Clow, W. L.; Lavik, M. T. pp 371-97 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

The effect of nuclear radiation on twelve commercial solid film lubricants was investigated. The films incorporating graphic and/or molybdenum disulfide were typically bonded with phenolic or epoxy resins. Gamma exposures covered the range 1×10^9 through 1×10^{12} ergs per gram carbon. Neutron dosages were measured over the range 3×10^{14} to 3×10^{16} nvt for films exposed to mixed reactor radiation. In addition, three experimental ceramic-bonded solid lubricant films were evaluated under the same dosages of gamma and neutron irradiation. No significant change in the wear-life of these films could be determined within the normal scatter of data. The effects of nuclear irradiation on the structure of eight lubricating solids and the friction of two lubricating solids were studied. Experiments on solid lubricant pellets showed that a gamma dose of 0.878×10^{12} erg/gm C causes an increase in friction. No change in lattice spacings for the gamma irradiated specimens was found. Graphite irradiated in mixed reactor flux to a neutron dose of 3.66×10^{20} nvt showed severe lattice damage even after subsequent annealing at 538°C. MoS_2 having the same irradiation and thermal history showed practically no perceptible changes in lattice spacing. (auth)

8851 DRY FILM LUBRICANTS IN RADIATION ENVIRONMENT. Demorest, K. E. (Marshall Space Flight Center, Huntsville, Ala.); Hopkins, V. pp 421-30 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

Wear-life results obtained on a Falex tester at room temperature and a 1,000-lb load for six bonded dry film lubricants are presented. Thirty tests were run on each film; ten each which were subjected to no radiation, 1 MeV electron irradiation of 2.8×10^{16} electrons/sq cm, and gamma irradiation of 2×10^6 roentgens. A statistical analysis of the wear-life data revealed that only two films were significantly affected by the radiation at the 90 percent confidence level; the electron irradiation appeared to improve their wear-life. All films are considered usable in a radiation environment that subjects them to the dosages used in this investigation in application for which they are suited in a non-radiation environment. (auth)

8852 SOME FEATURES OF A RADIATION STABILITY TEST METHOD FOR HYDRAULIC FLUIDS. Zaslavskii, Yu. S.; Zhukov, N. A. (All-Union Scientific-Research Inst. on Oil Refining, Moscow). pp 431-41 of Bearing and Seal Design in Nuclear Power Machinery. Burton, Ralph A. (ed.). New York, American Society of Mechanical Engineers, 1967.

From Symposium on Lubrication in Nuclear Application, Miami Beach, Fla., June 5–7, 1967. See CONF-670601.

In dynamic irradiation tests of hydraulic fluids, a cobalt radiation source as well as a nuclear reactor were used. The test results were dependent on the ratio of the energy received by the fluid from the pump and the absorbed radiation energy. A true comparative evaluation of the hydraulic fluid radiation stability can be obtained in dynamic irradiation tests performed under laboratory conditions corresponding to the specified service conditions of the test fluids in respect to the radiation dose rate, as well as the pump pressure in the hydraulic system and the fluid pumping cycles of the system. (auth)

8853 ANNEALING EFFECTS ON THE INTERNAL FRICTION AND THE DYNAMIC MODULUS OF PILE-IRRADIATED GRAPHITE. Saito, M. H.; Kawamura, K. (Nihon Univ., Japan). Tanso, No. 51, 7-10(Nov. 1967). (In Japanese).

A reactor grade graphite pile irradiated to the total dose of 5.8×10^{20} nvt (Ni) at 30°C was stepwise annealed between 100 and 2150°C, and examined for measurement of internal friction and of dynamic modulus at temperatures from 300 down to 80°K. The recovery process has been found to consist of three stages; the first stage caused by the annealing between 100 and 500°C, the second by that in the range 600 to 1150°C, and the third by the treatment between 1200 to 2150°C. The dynamic modulus recovers for the most part in the first stage, while the internal friction indicates little change. On the other hand, the recovery of internal friction takes place mostly in the third stage where the dynamic modulus shows a slight fall-off. In the second stage everything seems to have a recess. An analysis in the framework of the Granato–Luecke theory has yielded a considerable success in the evaluation of the interaction energy between dislocations and radiation-induced defects. A qualitative explanation for the formation and decomposition processes of interstitial clusters has been given in relation to the behavior of such anelastic properties. (NSA of Japan)

8854 WOOD-PLASTIC COMPOSITE MATERIALS. Laidlaw, R. A. (Forest Products Research Lab., Princes Risborough, Eng.). New Sci., 36: 551-3(Nov. 30, 1967).

A survey is given of the production of wood-plastic composite materials by irradiation and other techniques. Such materials offer many of the virtues of both components; they should not be regarded as substitutes for wood, but as new substances with their own specific properties. (UK)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 9129, 9152, 9153, 9206, 9305, and 9366.

8855 (SC-T-68-1500) SCINTILLATION OF STARS. Elsaesser, H. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Naturwissenschaften, 47: 6-10(1960). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The scintillation of stars or astronomic scintillation are designations for the brief brightness fluctuations of the starlight which can be observed continually even with the naked eye, as well as the local fluctuations of stars which manifest themselves through a telescope of a major focal length in an irregular to-and-fro oscillation of the focal images. Topics considered include measurement and reduction method (empirical data of scintillation), brightness scintillation, directional scintillation, the Hosfeld experiment, scintillation and wind velocities, magnitude of air schlieren, and theory of scintillation. (W.D.M.)

8856 (TID-24203, pp 5-15) RADIO ASTRONOMY. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Cosmic background measurements at 9.24 mm are presented. Other measurements using very-long-baseline interferometry with independent time standards are presented. (M.O.W.)

8857 (SC-T-68-1501) THEORY OF ASTRONOMICAL SCINTILLATION. PART I. Elsaesser, H.; Siedentopf, H. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Z. Astrophys., 48: 213-30(1959). 28p. Dep. CFSTI. JCL $2.60 fs, $1.04 mf.

The passage of visible starlight through the turbulent earth atmosphere is studied by means of geometrical and wave optics. In contrast to the hitherto published investigations, the scintillation phenomena are treated as resulting from the influence of the whole atmosphere. This is made possible by the assumption of a model atmosphere which consists of many turbulent layers one upon another. The changes in brightness and direction (seeing) of the light from stars near the zenith are discussed on the basis of a geometrical theory. By comparison of the brightness scintillation at sea-level with that observed at an altitude of 3600 m on Jungfraujoch an exponential decrease of the fluctuations in the index of refraction n with increasing height in the atmosphere is derived. The calculated rms fluctuation $\sigma(n)$ at sea level lies between $0.3 \cdot 10^{-8}$ and $1.3 \cdot 10^{-8}$, the equivalent fluctuation in temperature follows as $0.03 < \sigma(T) < 0.13$. The main contribution to the changes in brightness comes from atmospheric layers near 8 km above sea level, whereas the contributions to the changes in the direction of the incident light decrease exponentially with increasing height. (auth)

8858 PHYSICS OF COMETARY PLASMA. Wallis, M. K. (Univ. of Manchester, Eng.). Planet. Space Sci., 15: 1407-8(Sept. 1967).

Assuming that plasma instabilities, and possibly an enhanced interplanetary magnetic field, ensure the fluid behavior of cometary plasma, the production and flow of plasma in a carbon monoxide comet under the influence of the solar wind is investigated. The solar wind heats and compresses the cometary plasma. CO^+ production occurs mainly through electron-collisional ionization of the CO, in a region of slowly moving plasma sunward of the comet nucleus. This region is determined as the position of balance of the solar and cometary plasma momentum fluxes, and for various sizes of comets its distance lies in the range 2 to 50,000 km. Some 20 to 50 times further out, however, charge exchange processes (plus some photoionizations) become more important than electron collisions in causing ionization. Only the giant comets are efficient at ionizing the CO, and their plasma mostly occurs in envelopes at a distance of a few times 10^4 km, whence it flows at high velocity into tail rays. In the lesser comets much of the plasma is cooled to energies of a few eV through the electron collisional ionizations and excitations of CO molecules. This plasma flows on through the head and, before it reaches the tail, promotes the dissociation of complex molecules. Here may be identified the so-called "active region" or "false nucleus." (auth) (UK)

8859 MARINER V FLIGHT PAST VENUS. Snyder, Conway W. (Jet Propulsion Lab., Pasadena, Calif.). Science, 158: 1665-9(Dec. 29, 1967).

On October 19, 1967 the Mariner V spacecraft passed by Venus 10,151 kilometers from the center of the planet; the gravitational field, atmosphere, ionosphere, hydrogen corona, and interaction with the solar wind were observed. (auth)

8860 MARINER V: PLASMA AND MAGNETIC FIELDS OBSERVED NEAR VENUS. Bridge, H. S. (Massachusetts Inst. of Tech., Cambridge); Lazarus, A. J.; Snyder, C. W.; Smith, E. J.; Davis, L. Jr.; Coleman, P. J. Jr.; Jones, D. E. Science, 158: 1669-73(Dec. 29, 1967).

Abrupt changes in the amplitude of the magnetic fluctuations, in the field strength, and in the plasma properties, were observed with Mariner V near Venus. They provide clear evidence for the presence of a bow shock around the planet, similar to, but much smaller than, that observed at Earth. The observations appear consistent with an interaction of the solar wind with the ionosphere of Venus. No planetary field could be detected, but a steady radial field and very low plasma density were found 10,000 to 20,000 km behind Venus and 8,000 to 12,000 km from the Sun–Venus line. These observations may be interpreted as relating to an expansion wave tending to fill the cavity produced by Venus in the solar wind. The upper limit to the magnetic dipole moment of Venus is estimated to be within a factor of 2 of 10^{-3} times that of Earth. (auth)

8861 VENUS: AN UPPER LIMIT ON INTRINSIC MAGNETIC DIPOLE MOMENT BASED ON ABSENCE OF A RADIATION BELT. Van Allen, J. A.; Krimgis, S. M.; Frank, L. A.; Armstrong, T. P. (Univ. of Iowa, Iowa City). Contract Nonr 1509(06); Subcontract 951563. Science, 158: 1673-5(Dec. 29, 1967).

On the basis of the absence of energetic electrons ($E_e > 45$ keV and protons ($E_p > 320$ keV) associated with Venus to within a radial distance of 10,150 km from the center of the planet and using a physical similitude argument and the observational and theoretical knowledge of the magnetosphere of Earth, it is concluded that the intrinsic magnetic dipole moment of Venus is almost certainly less than 0.01 and probably less than 0.001 of that of Earth. Corresponding upper limits on the magnetic field at the equatorial surface of Venus are about 350 and 35×10^{-5} gauss, respectively. (auth)

8862 ULTRAVIOLET EMISSIONS OBSERVED NEAR VENUS FROM MARINER V. Barth, Charles A. (Univ. of Colorado, Boulder); Pearce, Jeffrey B.; Kelly, Kenneth K.; Wallace, Lloyd; Fastie, William G. Science, 158: 1675-8(Dec. 29, 1967).

A Lyman-alpha airglow of atomic hydrogen measured in the outer atmosphere of Venus showed that atomic hydrogen is present. The variation as a function of height indicates that the temperature of the upper atmosphere of Venus is lower than that of Earth. An ultraviolet airglow of atomic oxygen was not found. An ultraviolet nightglow was observed on the dark limb. (auth)

8863 VENUS: IONOSPHERE AND ATMOSPHERE AS MEASURED BY DUAL-FREQUENCY RADIO OCCULTATION OF MARINER V. Science, 158: 1678-83(Dec. 29, 1967).

Venus has daytime and nighttime ionospheres at the positions probed by radio occultation. The main layers are thin by terrestrial standards, with the nighttime peak concentration of electrons being about two orders of magnitude below that of the daytime peak. Above the nighttime peak were several scale-height regimes extending to a radius of at least 7500, and probably to 9700, kilometers from the center of Venus. Helium and hydrogen at plasma temperatures of 600 to 1100°K seem indicated in the regimes from 6300 to 7500 km, with cooler molecular ions in lower regions. Above the daytime peak a sharp plasmapause was discovered, marking a sudden transition from appreciable ionization concentrations near Venus to the tenuous conditions of the solar wind. This may be indicative of a kind of interaction of the magnetized solar wind with a planetary body that differs from the two different kinds of interaction characterized by Earth and by Moon. For Venus and probably for Mars, the magnetic field of the solar wind may pile up in front of the conducting ionosphere, form an induced magnetosphere that ends at the plasmapause, above which any ionosphere that tends to form is swept away by the shocked solar wind that flows between the standoff bowshock and the magnetopause. The neutral atmosphere was also probed and a surface reflection may have been detected, but the data have not yet been studied in detail. Results are consistent with a super-refractive atmosphere, as expected from Soviet measurements near the surface. Thus, two unusual features of Venus can be described in terms of a light trap in the lower atmosphere, and a magnetic trap in the conducting ionosphere. (auth)

8864 ATMOSPHERE AND IONOSPHERE OF VENUS FROM THE MARINER V S-BAND RADIO OCCULTATION MEASUREMENT. Kliore, Arvydas (Jet Propulsion Lab., Pasadena, Calif.); Levy, Gerald S.; Cain, Dan L.; Fjeldbo, Gunnar; Rasool, S. I. Science, 158: 1683-8(Dec. 29, 1967).

Measurements of the frequency, phase, and amplitude of the S-band radio signal of Mariner V as it passed behind Venus were used to obtain the effects of refraction in its atmosphere and ionosphere. Profiles of refractivity, temperature, pressure, and density in the neutral atmosphere, as well as electron density in the daytime ionosphere, are presented. A constant scale height was observed above the tropopause, and the temperature increased with an approximately linear lapse rate below the tropopause to the level at which signal was lost, presumably because heavy defocusing attenuation occurred as critical refraction was approached. An ionosphere having at least two maxima was observed at only 85 km above the tropopause. (auth)

8865 NOVA MODEL OF CENTAURUS XR-2. Edwards, P. J. (Univ. of Adelaide). Nature (London), 217: 43-4(Jan. 6, 1968).

Recent observations of the Centaurus region have established beyond doubt the existence of a variable x-ray source, Centaurus XR-2. Data quoted from rocket flights in 1967, together with the assumption of an optically thin x-ray source, suggest a model of the cooling source which is satisfied by the physical conditions expected in a circumstellar envelope shortly after a nova outburst. At the observed temperatures the radiation originates principally in electron proton bremsstrahlung. Polytropic gas expansion is implied, and it seems highly probable that the expansion was explosive and that the x radiation originated in a shell of shock heated gas. When first seen, on April 4th, the source was no more than a month or so old, having expanded to a radius of about 5×10^{14} cm (30 astronomical units). Values are deduced for mean electron density upper limit, total mass, emission measure, thermal energy content, luminosity, radiative life time, and distance. These parameters are typical of those deduced for recurrent novae from coronal line measurements. The blast wave solutions of Rogers are used to find a more detailed model of the expansion. Some additional support for the nova hypothesis comes from the optically observed deceleration of nova envelopes. (UK)

8866 RADIO SOURCES IN OPPOSITE DIRECTIONS AS A COSMOLOGICAL TEST. Solheim, J. E. (Univ. of Texas, Austin). Nature (London), 217: 41-3(Jan. 6, 1968).

From the observed distribution of quasars vs redshift an excess of sources with redshifts between 1.9 and 2.1 is observed. This effect may be explained in a cosmological model where the pole is in this redshift range. Models where the pole has a redshift of 2 to 3, or less, suggest an interesting cosmological test—the possibility of observing the same object in two opposite directions in the sky. The possibility that sources in the 4C radio catalogue may show this effect is discussed. Two images of the same object may be seen at different epochs, the time difference possibly being of the order of 10^9 years. If double image objects could be observed they would be expected to show a characteristic separation of at least 10′ from exact opposite positions. Pairs with separations up to 75′ were investigated. The distribution of the total pairs was what might be expected from a random distribution. Data are also given for the distribution of faint and bright pairs separately. There was evidence for an excess of faint sources in almost exactly opposite positions as given in the 4C catalogue. Possible explanations may be found in phenomena such as clustering effects (or perhaps unrecognized systematic errors of position determination in the catalogue). The author suggests, however, that the effect is the result of the well-known cosmological property that in some closed Universe models it should be possible to see the same object in two opposite directions. (UK)

8867 EXTINCTION BY INTERSTELLAR SILICA GRAINS. Knacke, R. F. (Univ. of California, Berkeley). Nature (London), 217: 44-5(Jan. 6, 1968).

Interest has recently been expressed in the possibility that interstellar dust may contain a silica component. SiO_2 shows strong absorptions in the 8- to 14-μ atmospheric "window," which should be observable with ground based infrared telescopes. The author computed normalised extinction spectra for crystalline quartz and vitreous silica, and estimated the approximate size of interstellar silica grains as typically 0.2 μ. Extinction by small spheres is greatest at 8.7 μ. (UK)

8868 DETECTION OF AN ANISOTROPIC SOFT X-RAY BACKGROUND FLUX. Bowyer, C. S.; Field, G. B.; Mack, J. E. (Univ. of California, Berkeley). Nature (London), 217: 32-4(Jan. 6, 1968).

The cosmic x-ray background has been found to be anisotropic. It is interpreted as being made up of two components: an isotropic background, possibly of extragalactic origin, and an anomalous emission, perhaps located within the Galaxy. (auth) (UK)

8869 RADIO-EMITTING ELECTRONS IN THE GALAXY AND THE SOLAR MODULATION OF COSMIC RAYS. Anand, K. C.; Daniel, R. R.; Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Nature (London), 217: 25-7(Jan. 6, 1968).

The energy spectrum of electrons in interstellar space needed to explain the Galactic background radio emission has been derived. Information can be deduced about the solar modulation of cosmic-ray electrons. (auth) (UK)

8870 NUMERICAL CALCULATIONS ON RELATIVISTIC COSMOLOGICAL MODELS. Refsdal, S.; Stabell, R.; de Lange, F. G. Mem. Roy. Astron. Soc., 71: 143-248(1967).

The following quantities are calculated for different world models and for different values of the red shift z: apparent bolometric magnitude, angular diameter, and radio flux density of a standard object, the number of objects and the travel time of light. For small values of the red shift all the calculated quantities are most sensitive to variations of the deceleration parameter q_0. For larger values of the red shift ($z \geq 1$), however, it is found that these quantities are most sensitive to variations of the density parameter σ_0. The age of the Universe and the horizons are calculated for different models. (auth) (UK)

8871 THE ATMOSPHERE ON β DORADUS. III. HYDROGEN LINE PROFILES. Bell, R. A.; Rodgers, A. W. Mon. Notic. Roy. Astron. Soc., 135: 121-9(1967).

Profiles of the Hα line were measured from high-dispersion spectra of the cepheid β Doradus distributed throughout the cycle. These profiles are compared with theoretical profiles computed from grey model atmospheres and the agreement is satisfactory in the line wings but not in the line cores. Agreement in the line cores is obtained if line absorption in the stellar chromosphere is postulated. The chromospheric Doppler broadening of Hα is consistent with that derived from K2 emission widths, using a relation given by O. B. Wilson. The effective temperature of β Doradus, derived from the line wings, shows only a small variation with phase. The minimum effective temperature is 5900° at $P = 0.58$, while the maximum is 6350° at $P = 0.83$. (auth) (UK)

8872 EVIDENCE ON THE ISOTROPY OF FAINT RADIO SOURCES. Hughes, R. G.; Longair, M. S. Mon. Notic. Roy. Astron. Soc., 135: 131-7(1967).

The isotropy of faint radio sources was investigated by applying Scheuer's statistical method to the interferometer records of the 4C survey in the declination range –07° to +80°. There is no evidence of anisotropy in the distribution of sources having flux densities greater than 0.2×10^{-26} w.m^{-2} Hz^{-1} at 178 MHz. It is concluded that this observation renders the "local origin" hypothesis of quasi-stellar sources highly improbable. In evolutionary cosmologies the Universe is isotropic on a large scale to a red shift $z \approx 4$. (auth)

8873 OBSERVATIONS OF PLANETARY NEBULAE AT THREE MICROWAVE FREQUENCIES. Davies, J. G.; Ferriday, R. J.; Haslam, C. G. T.; Moran, M.; Thomasson, P. Mon. Notic. Roy. Astron. Soc., 135: 139-46(1967).

The 125 × 83 ft fully steerable Mark II radio telescope at Jodrell Bank was used in a recent attempt to detect radio emission at three frequencies, 4995, 2695, and 1420 Mc, from twenty-four of the brighter planetary nebulae. An additional twenty-six planetary nebulae were observed at two frequencies, 4995 and 2695 Mc, and a further forty-four planetary nebulae observed at 2695 Mc only. Two Wolf–Rayet stars, HD 193793 and HD 16523, were also observed at 2695 Mc. The observations suggest that the majority of the nebulae are thermal radio sources. The radio flux densities for those nebulae which have been shown to have become optically thin in this frequency range agree well with values predicted from recombination theory. (auth) (UK)

8874 COMMENTS ON PLASKETT'S, "THE POLAR ROTATION OF THE SUN." Ward, F. Mon. Notic. Roy. Astron. Soc., 135: 147-8(1967).

Previous analyses of sunspot proper motions strongly suggest that the horizontal wind field in the solar atmosphere is characterized by "Rossby" waves. Such a circulation pattern would very likely be very complex in space, and time-variable. Therefore, Plaskett's attempt [Mon. Notic. Roy. Astron. Soc., 131: 407(1966)] to verify their existence by spectroscopic observations would require a much more extensive sample of data than is presented in his paper. (auth) (UK)

8875 MODEL ATMOSPHERES FOR CENTRAL STARS OF PLANETARY NEBULAE. Gebbie, K. B. Mon. Notic. Roy. Astron. Soc., 135: 181-97(1967).

The central stars of planetary nebulae have effective temperatures ranging from 3×10^4°K to about 2×10^5°K. In order to obtain a better understanding of the nature of very hot stars, nine model atmospheres were computed for stars of effective temperature between 1×10^5 and 2.5×10^5°K, and differing values of surface gravity. All the models have the same chemical composition, the ratio of helium to hydrogen being 0.176 by numbers of atoms. The temperature distribution and radiation pressure gradient are approximated by that of a grey body, and a Rosseland mean absorption coefficient is used. A new method for deriving the source function of very hot stars is given, together with an outline of the present numerical calculations. It is shown that in hot stars of low density, where electron scattering is the dominant source of opacity, emission features are to be expected, but that with increasing density, these will reverse into absorption. (auth) (UK)

8876 EFFECT OF A TOROIDAL MAGNETIC FIELD ON THE RADIAL OSCILLATIONS OF STARS. **Roxburgh, I. W.; Durney, B. R. Mon. Notic. Roy. Astron. Soc., 135: 329-37 (1967).**

The internal structure of a polytrope $n = 3$ containing a toroidal magnetic field is investigated. For static equilibrium configurations the general solution for the structure of the field is given, and a particular solution $H_t \propto r\rho \sin\theta$ is investigated in detail. The linearized equations for small radial motion about the equilibrium configuration are presented, and with a time dependence $\propto e^{i\sigma t}$ these equations reduce to an eigenvalue equation for σ^2. A variational principle for determining σ is derived, and σ^2 is estimated using this principle, as well as by direct numerical iteration, for values of the ratio of specific heats of the gas $\Gamma = 4/3$, $4/3 + 0.01$, and 5/3. Results are given for different field strengths. For $\Gamma = 4/3$ the star is neutrally stable whether or not there is a magnetic field, whereas for the other values of Γ the magnetic field decreases the value of σ as compared to the nonmagnetic values. (auth) (UK)

8877 ULTRAVIOLET EMISSION SPECTRUM OF THE SOLAR CHROMOSPHERE AND CORONA. **Burton, W. M.; Ridgeley, A.; Wilson, R. Mon. Notic. Roy. Astron. Soc., 135: 207-23(1967).**

A stabilized Skylark rocket flown on April 9, 1965, provided observations of the emission spectrum of the solar chromosphere and corona. Servo-controlled alignment systems stabilized an image of the Sun with an accuracy of a few seconds of arc relative to the spectrograph slit, which was set at about 10 arcsec outside the solar limb. The ultraviolet spectrum between 950 and 2950 Å was recorded on photographic film at altitudes from 100 to 160 km. About 300 emission lines were observed, and a list of wavelengths with estimated intensities is given, together with identifications for about three-quarters of the observed lines. New identifications include intersystem transitions in C III, N IV, O V, and new forbidden transitions in Fe XI and Fe XII. The intensities of the chromospheric emission lines are compared with previous measurements obtained by direct observation of the solar disk. (auth)

8878 CONVECTIVE CORES IN STARS. **Tayler, R. J. Mon. Notic. Roy. Astron. Soc., 135: 225-9(1967).**

A simple extension is given of a criterion of Naur and Osterbrock for the occurrence of convective cores in stars. It is shown that the new criterion agrees with the existence of a convective core in a recent main sequence stellar model of Bennick and Motz (Astrophys. J., 141: 195(1965)), even though the P−P chain is responsible for the majority of the energy generation throughout the core. It is suggested that low-mass main-sequence stars with no convective core may develop such cores as they evolve into the giant branch. (auth) (UK)

8879 IDENTIFICATIONS OF RADIO SOURCES WITH BRIGHT GALAXIES. **Caswell, J. L.; Wills, D. Mon. Notic. Roy. Astron. Soc., 135: 231-42(1967).**

The positions of radio sources in the 4C catalogue were compared with those of bright galaxies in the catalogues of Vorontsov−Velyaminov and Zwicky, and a number of identifications are suggested. Several additional sources observed in a survey using a pencil beam instrument were also identified with galaxies in the lists. The coincidences are mainly with "strong" radio galaxies, but a few "normal" galaxies are included in the pencil beam survey. Thirty-six sources from pencil beam data form an homogeneous sample from which the distribution of radio luminosity among sources of this type has been investigated, and modifications to Longair's model luminosity function are derived. (auth) (UK)

8880 TYPES OF VELOCITY DISTRIBUTION AND STABILITY OF DISC GALAXIES. **Graham, R. Mon. Notic. Roy. Astron. Soc., 137: 25-39(1967).**

The local stability analysis of rotating sheets due to Toomre is generalized for all elliptically symmetric velocity distributions. The velocity distribution of least energy for which a disc is stable to axisymmetric disturbances of all wavelengths is a δ function, i.e., one in which all Lindblad epicycles are equal; it has about 20% less energy than the Schwarschild distribution, which has just sufficient energy for stability. It is suggested that an instability in the galaxy produces a more stable velocity distribution, typically having fewer stars with small peculiar velocities. This should be observable in classes of old stars. If a large proportion of mass has small peculiar velocities, then the total dispersive energy required to produce stability is large, especially at short wavelengths. A velocity distribution consisting of three components, and which approximates to that of our Galaxy, could explain the spiral arm spacing. The components are (i) 75% by mass of old stars with high velocity dispersion, (ii) 20% by mass of stars and gas clouds with low-medium velocity dispersion, and (iii) 5% by mass of clouds with very low velocity dispersion. A velocity distribution consisting of four components, which might be considered to be an evolution of that with three, due to the decaying dispersion of the gas clouds, has a most unstable wavelength which could explain the spiral arm spacing in Andromeda. (auth) (UK)

8881 CHEMICAL COMPOSITION AND ULTRAVIOLET EXCESS OF G DWARFS. **Alexander, J. B. Mon. Notic. Roy. Astron. Soc., 137: 41-54(1967).**

New values of [Fe/H] were derived for 18 of the G dwarfs for which Wallerstein has published abundance determinations, and the original measurements of equivalent width were subjected to different methods of analysis. The general agreement with the earlier results of Wallerstein and his collaborators is good; the present values of [Fe/H] of +0.2 or +0.3 obtained for the Hyades, however, differ considerably from those derived previously. It appears that for most G dwarfs in the solar neighborhood the ultraviolet excess does not depend to any large extent on factors other than metal abundance, surface gravity, and temperature. (auth) (UK)

8882 A COLOUR–MAGNITUDE ARRAY FOR A REGION IN THE CORE OF THE SMALL MAGELLANIC CLOUD. **Basinski, J. M.; Bok, B. J.; Bok, P. F. Mon. Notic. Roy. Astron. Soc., 137: 55-67(1967).**

The color−magnitude array for a core region in the Small Magellanic Cloud is depicted. The comparable array for a galactic comparison field with an area sixteen times that of the Small Cloud field and at a somewhat lower galactic latitude is also shown. The great majority of the stars with $-0.40 < B - V < +0.40$ is shown, and also most stars with $B - V < +1.20$, are obviously members of the Small Cloud. It is shown that there is no evidence for appreciable effects of galactic or Small Cloud interstellar reddening in the material. The limit of the survey is $M_v = -4$. (auth) (UK)

8883 CLASSIFICATION OF UNIFORM COSMOLOGICAL MODELS. **Harrison, E. R. Mon. Notic. Roy. Astron. Soc., 137: 69-79(1967).**

Homogeneous and isotropic models of relativistic cosmology are classified according to a general scheme. There are four main groups: static, asymptotic, monotonic, and oscillatory, and each group is subdivided into classes. Altogether, there are eleven classes of cosmological models. In recent years models have been proposed which contain negative pressure. Robertson's original scheme of classification therefore requires development, as in the treatment described, to take into account the possibility of a negative cosmic stress. As a consequence there emerges a wide variety of cosmological models, including models that are both static and stable and models that oscillate between finite values of density. (auth) (UK)

8884 OBSERVATIONS OF TWELVE RADIO SOURCES AT A WAVELENGTH OF 0.73m WITH A TRACKING INTERFEROMETER HAVING A BASELINE OF 180,000 WAVELENGTHS. **Anderson, B.; Donaldson, W. Mon. Notic. Roy. Astron. Soc., 137: 81-94(1967).**

Angular structure measurements on twelve radio sources were made at 0.73 m with a long-baseline tracking interferometer. Each source was observed continuously while the effective baseline varied in the range 60,000 to 180,000 wavelengths. The normalization of the results is discussed, and a new calibration procedure applied. An attempt was made to fit simple source models to the observations. The fringe visibilities of three sources are close to unity at all hour angles, and as a result it is only possible to give upper limits to their dimensions. The other nine sources are partially resolved at some or all hour angles, and for four of them the position angles and angular sizes of the major axes are given. Four sources are found to consist of two components. For two of these double sources the component separation and position angle are determined with an order of magnitude greater accuracy than has previously been achieved. The remaining source gives striking evidence of variations in source structure with wavelength. (auth) (UK)

8885 STRUCTURE OF NARROW SHELLS IN RED GIANTS. Eggleton, P. P. Mon. Notic. Roy. Astron. Soc., 135: 243-50(1967).

Stars of moderate mass (1 to 2 $M_\odot$) which have reached the red giant stage contain a helium core surrounded by a thin hydrogen burning shell, beyond which there is a region in radiative equilibrium. A method is given for computing in some detail the structure of the shell source, largely independently of the rest of the star, and the results of this method are compared with the zero-order approximation (Schwarzschild Structure and Evolution of Stars, Princetown University Press 1958) in which the shell source is treated as a jump discontinuity in composition and luminosity. A similar method is given for obtaining the energy released by gravitational contraction in the narrow shell of nondegenerate helium immediately below the hydrogen burning shell. (auth) (UK)

8886 THE PECULIAR STAR HD 101065. PART I. Przybylski, Antoni. Postepy Astron., 15: 225-39(1967). (In Polish).

The eighth-magnitude star HD 101065 has a very peculiar spectrum characterized by the absence of "normal" elements such as iron, titanium, chromium and great strength of very numerous lines of the rare earths. The effective temperature of the star obtained from six-color photometry is 6200°K. The low radial velocity (+10.5 km/sec) coupled with fairly large proper motion indicates that it is probably a main-sequence dwarf. In all probability it is a cool star identical in status with peculiar A stars. It shows the highest-known blanketing effect. The analysis of the spectrum shows that calcium is underabundant by 3.8 in the logarithmic scale, iron by at least 4.1, while the rare earths are overabundant by 1.9 up to 3.6. (auth)

8887 EVOLUTION OF NUCLEI OF THE PLANETARY NEBULAE. Sroczynska, Magdalena. Postepy Astron., 15: 241-9(1967). (In Polish).

The newest observational data concerning the nuclei of the planetary nebulae are presented and compared with some theoretical models of objects which evolve into white dwarfs. (auth)

8888 CLOSE BINARY SYSTEMS. PART I. Smak, Jozef. Postepy Astron., 15: 251-71(1967). (In Polish).

A review is given of selected observational results and problems in the field of the close binary systems. (auth)

8889 GALAXIES AS GRAVITATIONAL LENSES. Sadeh, Dror (Hulburt Center for Space Research, Washington, D. C.). Science, 158: 1176-8(Dec. 1, 1967).

The probability that a galaxy gathers light from another remote galaxy, and deflects and focuses it toward an observer on Earth, is calculated according to various cosmologic models. The question is posed of whether an object called a quasar is a single, intrinsically luminous entity or the result of accidental alignment, along the line of sight, of two normal galaxies, the more distant of which has its light amplified by the gravitational-lens effect of the nearer galaxy. If galaxies are distributed at random in the Universe, the former alternative is true. But, if we assume that most galaxies exist in pairs, we can find about 30 galaxies occurring exactly one behind the other in such a way as to enable amplification of the order of 50. This model explains also the variations in intensity in quasars, but fails to explain others of their observed properties. (auth)

8890 SYSTEMATIC MOTIONS IN STAR GROUPS. Meurers, Joseph (Univ. Sternwarte, Vienna). Z. Astrophys., 67: 255-67 (1967). (In German).

It is possible to select in galactic fields groups of stars of uniform spectral type having the same internal systematic motions (expansions) as OB=associations. The duration of these motions and the spatial dimensions are also the same. It is possible to construct two-dimensional vector fields with random distribution of the directions of vectors and with the same distribution of spectra as in real selected areas. It is demonstrated, that in such artificial random fields systematic motions, especially expansions, are found, being guaranteed in a statistical sense as well as in many OB=associations. A comparison of selected areas Nr. 8, 9, 18, and 19 with artificial fields shows, that in these areas expansions are more frequent than in artificial random fields. (auth)

8891 GRAVITATIONAL INSTABILITY OF AN INTERFACE SEPARATING TWO SEMI-INFINITE MEDIA. Verma, Pratibha; Verma, Y. K. (Univ. of Delhi). Z. Astrophys., 67: 268-70 (1967).

Gravitational instability of an interface separating two semi-infinite homogeneous media of densities q_1 and q_2 is investigated. The two media are assumed to be moving in opposite directions with a uniform velocity U_0 along the interface. The critical wavelength at which the gravitational instability sets in at the interface is $\lambda^* = \pi\{[(C_1^2 + C_2^2)/2 - U_0^2]/\pi G[(q_1 + q_2)/2]\}^{1/2}$. In the absence of streaming, Jeans' growth rate for the instability becomes $\sigma^2 = 4\ \pi G(q_1 + q_2)/2 - [(C_1^2 + C_2^2)/2]k^2$. (auth)

8892 SECULAR STABILITY BEHAVIOR OF CHEMICALLY INHOMOGENEOUS ZONES IN STARS. Kippenhahn, Rudolf (Univ. Sternwarte, Goettingen, Ger.). Z. Astrophys., 67: 271-82(1967). (In German).

The study of secular stability of chemically inhomogeneous layers against nonspherical perturbations is reduced to a self-adjoint eigenvalue problem which in each practical case can be solved numerically. A condition sufficient for stability is derived analytically. Furthermore, the limit case of perturbations of extremely short wavelength is treated and a destabilizing effect in shell sources is found. (auth)

8893 PREDICTED COLOR INDICES FOR QUASI-STELLAR OBJECTS WITH RED SHIFTS LARGER THAN 2.2. Grewing, Michael (Astronomische Inst., Bonn). Z. Astrophys., 67: 283-5(1967).

U−B and B−V values are predicted for quasi-stellar objects with red shifts z larger than 2.2. These predictions are based on a semi-empirical "standard intensity distribution," assuming a 0, 10, 20, and 50% dimming for radiation shortward of 912 Å. It turns out that for $2.3 \leqq z \leqq 3.0$ the variation of both, U−B and B−V is surprisingly small. The predicted color-indices for this range of z are thus confined to a very small area in the two-color diagram. This might be an explanation why objects with red shifts larger than 2.2 have so far not been observed. (auth)

8894 LUMINOSITY FUNCTION AND SPACE DENSITY OF WHITE DWARFS. Weidemann, Volker (Univ., Kiel). Z. Astrophys., 67: 286-305(1967). (In German).

Lines of constant cooling time are calculated according to the theory of Mestel and Ruderman, 1967, and drawn in an improved H−R diagram of white dwarfs. The position of the coolest stars confirms conclusions from stellar evolution which indicate an interior composition of heavier elements rather than He. White dwarfs of 0.6 $M_\odot$, composed of each 50% C and O, reach a limiting bolometric magnitude of $M_b = 16.5$ ($T_{eff} = 3400°K$) within the age of the galaxy (10^{10}a). Luminosity functions are then derived from observational material. If reduced to a bolometric scale and if selection effects are properly taken into account, they follow closely theoretical relations which are predicted by the Mestel−Ruderman theory under the assumption of a constant white dwarf birth rate. The space density is estimated in different ways and turns out to be considerably higher than hitherto assumed. With most probably 100 and 200 white dwarfs within 10 parsec the mass contribution in the solar neighborhood is 1 to $2 \cdot 10^{-24}$ g/cm^3. It may be higher and could completely account for the mass deficit from Oort's estimate. The coolest white dwarfs, if they exist, are not yet identified. Extension of the luminosity function to higher temperatures as well as comparison with nuclei of planetary nebulae gives no indication of the existence of a "gap" at $0 < \log L/L_\odot < +2$ as recently proposed by Stothers to be taken as evidence of weak interaction neutrino cooling. (auth)

8895 SOUTHERN PECULIAR GALAXIES. III. A GROUP IN CENTAURUS. Sersic, J. L. (Univ. Nacional, Cordoba, Argentina). Z. Astrophys., 67: 306-11(1967).

A group of galaxies in Centaurus is described and the apparent magnitudes, radial velocity, and absolute magnitudes are given. This group contains a peculiar galaxy with very remarkable characteristics. (auth)

8896 EFFECT OF ANISOTROPY AND DEPTH DEPENDENCE OF MICROTURBULENCE ON STELLAR SPECTRA. Hardorp, Johannes; Scholz, Michael T. (Hamburger Sternwarte, Hamburg). Z. Astrophys., 67: 312-14(1967).

Anisotropic, depth-independent microturbulent motion may have a similar effect on stellar spectra as an isotropic, but depth-dependent, microturbulence. (auth)

8897 MAGNETIC-GRAVITATIONAL ANALOGY AND THE POSSIBLE CONSEQUENCES FROM GENERAL RELATIVITY IN COSMOGONY. Gurovich, V. Ts. (Inst. of Physics and Mathematics, Frunze, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 193-6(Sept. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 712-15(Sept. 15, 1967).

The tensor nature of the gravitational field leads, even in the linear approximation, to additional forces that act on a moving particle and which in principle are absent in Newton's gravitation theory. Abdildin advanced certain hypotheses concerning the influence of these forces during the formation of the solar system. Without ascertaining the causes of the coplanarity of planetary orbits, it is of interest to estimate the perturbations caused by general relativity effects in the planet parameters. It is proposed that the calculations start not from the Lagrangian of the system of the gravitating bodies, but from the magnetic–gravitational analogy. (W.D.M.)

8898 RADIO SPECTRA AND FERMI ACCELERATION BY SHOCKS. Hudson, P. D. Mon. Notic. Roy. Astron. Soc., 137: 205-20(1967).

It is shown that a power law energy spectrum can be generated in a trap formed by shocks. Values for the rate of loss of particles from the trap are given, and means of reducing these are discussed. Mirror velocities of the order of 10,000 to 1,000 km/s are required to produce the observed spectrum, but these are needed in only a few of the traps in the accelerating region. It is shown that the increase in pressure of the relativistic gas in most circumstances sets a lower limit to the slope of the energy spectrum produced. This is used to explain the fact that the same spectrum is produced throughout the source. For one model the range of values of the radio spectrum is found to coincide with the maximum in the observed distribution of the radio spectra. (auth) (UK)

8899 UNIFYING THEORY OF GALACTIC FORMS AND ACTIVITY. Piddington, J. H. (CSIRO, Sydney). Planet. Space Sci., 15: 1625-40(Nov. 1967).

The magnetic fields of galaxies must develop from a much weaker, large-scale intergalactic field B_0. This field partially controls gas motions and hence influences rates and patterns of star formation. It gives a blueprint of evolution and accounts for the notable differences in forms and activity of galaxies, including spirals, radio galaxies, exploding nuclei and quasi-stellar sources. When B_0 is parallel to the rotational axis, the disk is in isorotation and free of hydromagnetic motions; star formation is not inhibited, and a featureless, gas-free disk or SO galaxy results. When B_0 is perpendicular to the rotational axis magnetic pressure creates a spheroid (elliptical or E galaxy) rather than a disk. Magnetic braking removes angular momentum, increases density and converts gravitational to magnetic and kinetic energy. The oblique-field case is very complex. Twin spiral arms are permanent pressure waves in the gas of the disk caused by varying external magnetic pressure and gas motions perpendicular to the disk. Increased gas pressure leads to increases in the number of young stars which render the arms visible. The central spheroidal system is a regional of magnetic-field-winding and is virtually a miniature E galaxy. Spheroidal systems (E galaxies and the centers of spirals) become unstable when the field is wound too tightly, and explode to form radio galaxies or coronas. Quasi-stellar sources may be spheroidal systems in which star formation has been inhibited. Spheroidal systems may have great cosmological significance, contributing significantly to the magnetic flux and cosmic-ray content of the Universe, and even being the sites of creation of matter. (auth) (UK)

8900 VELOCITY, RADIUS, AND LIGHT VARIATIONS OF THE CEPHEID U SGR. Breger, M. Mon. Notic. Roy. Astron. Soc., 136: 61-9(1967).

New radial velocities and photoelectric measurements of the classical cepheid U Sgr in M 25 are given. A slightly larger period is suggested by comparing different velocity determinations. The mean radius and radius variations are calculated by the Wesselink Method and a mean radius of 53.8 ± 3.4 (s.e.) solar radii is derived. The corresponding parallax yields a distance modulus m − M = 9.15 ± 0.3 in good agreement with the value m − M = 9.08 ± 0.2 for the cluster M 25 derived by Wampler et al. (Astrophys. J. Vol. 133, page 845. (1961)). (auth) (UK)

8901 LINE CONTOURS IN SUNSPOT REGIONS. Adam, M. G. Mon. Notic. Roy. Astron. Soc., 136: 71-90(1967).

Line contours were measured for Fe I 6302.5 Å across sections of a sunspot towards the west limb of the Sun. The contours were obtained in light plane polarized in the NS and EW planes. As simultaneously as possible magnetic field strengths and directions and Evershed velocities were measured in the fringed spectra taken through a Babinet prism, according to the method introduced by Treanor. The observations form the basis for an investigation of suggested abnormalities in the component intensities in Zeeman split lines. The contours observed in plane polarized light are free from the effects of telescope polarization, and give a more sensitive test of observation and theory than contours obtained in natural light. The observed contours are compared with theoretical calculations based on Stepanov's theory of line formation for Zeeman components. Although the observed equivalent widths show a marked difference between the two polarization planes, this difference is quite in accord with the theory; moreover, when the effect of scattered light is taken into account the observed contours are not anomalous. The observational procedure described is proposed as a sensitive method of investigating possible abnormalities in line contours in larger sunspots. (auth) (UK)

8902 TEMPERATURES AND PULSATION MODE OF NINE-DAY CEPHEIDS. Rodgers, A. W.; Bell, R. A. Mon. Notic. Roy. Astron. Soc., 136: 91-9(1967).

Hα line profiles of the 9-day cepheids S Mus and β Dor, and of non-variable F and G supergiants, are compared with computed profiles to obtain effective temperatures. The hydrogen line temperatures are about 100°K higher than the Oke cepheid temperature scale. The intrinsic color–period relation is considered for cepheids of types AB and C. No evidence is found that type C cepheids are systematically hotter than type AB. There is thus no indication that type C stars pulsate in a higher mode than those of type AB. The minimum width of the instability zone at P = 10 days is 0.24 in B−V. Spectra of S Mus are discussed, and no evidence of a faint companion is found. (auth) (UK)

8903 STATISTICAL MECHANICS OF VIOLENT RELAXATION IN STELLAR SYSTEMS. Lynden-Bell, D. Mon. Notic. Roy. Astron. Soc., 136: 101-21(1967).

An explanation of the observed light distributions of elliptical galaxies is sought and found. The violently changing gravitational field of a newly formed galaxy is effective in changing the statistics of stellar orbits. The equilibrium distribution under this encounterless relaxation is found by use of a fourth type of statistics related to both Fermi–Dirac statistics and equipartition of energy per unit mass. In the relevant limit this becomes Maxwell's distribution but with temperature proportional to mass. The predicted light distributions are those of the modified isothermal spheres developed by Michie from considerations of stellar relaxation in globular clusters. Both these, and the special case further developed by King, are known to give agreement with observations of spherical systems. Application to clusters of galaxies will remove Zwicky's paradox. The theory is also developed for rotating systems, where allowance must be made for anisotropy of stellar motions if the outer parts are not to be much flatter than the inner parts. The new statistics developed should have important applications to collisionless plasmas and collisionless shocks. Kelvin's theorem is rederived for collisionless dynamics. It is suggested that the typical "equilibrium" state of a stellar system may be hierarchical. (auth) (UK)

8904 OPTICAL IDENTIFICATIONS OF SELECTED 4C RADIO SOURCES. Wills, D. Mon. Notic. Roy. Astron. Soc., 135: 339-43(1967).

The declinations of sixty-four 4 C sources were measured, with uncertainties of about ±15" arc, and a search for optical identifications of the sources is described. (auth) (UK)

8905 STUDIES IN RADIO SOURCE STRUCTURE. I. A RELATIVISTICALLY EXPANDING MODEL FOR VARIABLE QUASI-STELLAR RADIO SOURCES. Rees, M. J. Mon. Notic. Roy. Astron. Soc., 135: 345-60(1967).

The rapid variations in the flux from some quasars at centimeter wavelengths are known to be incompatible with most models of these objects, which assume that they emit synchrotron radiation and are at cosmological distances. It is shown that this difficulty can be resolved if the sources expand relativistically. The flux variations from a source of synchrotron radiation expanding with a velocity ~c can, in principle, be arbitrarily rapid. It is argued that relativistic explosive velocities could in fact arise in compact radio sources, and that models of this kind, with reasonable parameters, could account for the observed radio fluctuations of quasars. (auth) (UK)

8906 FURTHER RADIO STUDIES OF SOURCES IN THE FOURTH CAMBRIDGE CATALOGUE. Stewart, P.; Long, R. J. Mon. Notic. Roy. Astron. Soc., 135: 361-76(1967).

An account is given of the experimental procedures used in a recent spectral survey of 4C sources, together with further spectral information on sources with 4C flux densities less than 5 × 10^{-26} w.m^{-2}(c/s)$^{-1}$. The angular scales of most of the 4C sources with flux density greater than this value, lying between 20° and 40° declination, and with $|b^{II}| > 30°$ are also given. (auth) (UK)

8907 PHOTOELECTRIC Hβ PHOTOMETRY IN SEVEN OPEN CLUSTERS AND IN THE SCORPIO–CENTAURUS ASSOCIATION. Graham, J. A. Mon. Notic. Roy. Astron. Soc., 135: 377-90(1967).

Observations of the photoelectric Hβ index, as defined by Crawford, were made in the open clusters NGC 2264, IC 2391, Trumpler 18, NGC 4755, NGC 6087, NGC 6383, IC 4725, and in the southern part of the Scorpio–Centaurus association. Using a preliminary calibration of the Hβ index in terms of absolute magnitude, new distance moduli and distances are derived, and the new distance moduli are compared with values found independently by other observers. A transformation between the Hβ index and equivalent width is also presented, and it is shown that Hβ equivalent widths derived through the Hβ index compare favorably with those found by spectrophotometric methods. (auth) (UK)

8908 ISOPHOTOMETRY OF THE 30 DORADUS NEBULA. **Faulkner, D. J.** Mon. Notic. Roy. Astron. Soc., 135: 401-12 (1967).

Balmer-line isophotes, calibrated in absolute units of surface brightness, are presented for the 30 Doradus Nebula. These are used to predict the corresponding flux of thermal emission from the nebula at radio frequencies, and a comparison with observed radio fluxes shows that there is a good agreement with the observations have been made with a sufficiently narrow beam width. A value of 7 is found for the ratio of visual absorption of reddening, $R = A_V/E_{B-V}$. An upper limit mass estimate of 5×10^5 M$_\odot$ is obtained for the nebula, and evidence is presented that the system is not gravitationally bound. (auth) (UK)

8909 THE DEPENDENCE OF INTERSTELLAR REDDENING ON LUMINOSITY AMONGST O AND B STARS. **Reddish, V. C.** Mon. Notic. Roy. Astron. Soc., 135: 251-74(1967).

The increase of interstellar reddening of stars with increasing stellar luminosity, found by Blanco and Williams (Astrophys. J. Vol. 130., p 482 1959) in the Cepheus IV association, has been found to occur in all clusters and associations containing stars brighter than $M_v = -9$ (ages < 10^5 year). It is sometimes present in systems with ages in the range 10^5 year to 2×10^6 year, never in systems older than 2×10^6 year. The effect is found most strongly in the Cygnus II association (Reddish, Lawrence and Pratt 1966). It is concluded that very young early-type stars are surrounded by obscuring clouds having diameters $\leq$ 1 pc and masses probably ~30 M$_\odot$. Disappearance of the clouds probably occurs through contraction to disks. The clouds may be remnants of those from which the stars formed. Wolf–Rayet stars are usually found in star systems which show the effect rarely in those that do not. Sytems showing the effect are absent from the anticenter quadrant, which is also devoid of Wolf–Rayet stars. Bok's globules show a similar distribution. (auth) (UK)

8910 POLARIZATION IN η CARINAE. **Visvanathan, N.** Mon. Notic. Roy. Astron. Soc., 135: 275-86(1967).

The object η Carinae was observed for polarization with a 22 second aperture in six filters, distributed from U to IR. The polarization remains constant with wavelength. The emission line Hα is polarized. The position angle of the electric vector remains nearly constant for all wavelengths and is parallel to the minor axis of the elliptical envelope of η Carinae. Observations of polarization were also made with apertures 3 s, 13 s, and 22 s centered at the nucleus of η Carinae. The polarization within 3 s of arc is as high as 4.2%, and increases in the annuli at greater distances from the center. Six stars within $1\frac{1}{2}$ min around η Carinae show polarization less than half of that found in η Carinae with a 22 s aperture. The position angles of the electric vector are nearly parallel to each other and different from that of η Carinae. The wavelength dependence of interstellar polarization derived for the stars in the η Carinae nebula region does not show constancy with wavelength. Consideration of the spectrum of η Carinae shows that the line radiation as well as the continuum is polarized, suggesting that Thompson scattering by free electrons may be responsible for the polarization observed in η Carinae. (auth) (UK)

8911 THE SUPERGIANT ECLIPSING SYSTEM BL TELESCOPII. **Feast, M. W.** Mon. Notic. Roy. Astron. Soc., 135: 287-304(1967).

The long period (778^d) eclipsing system BL Tel is discussed on the basis of the spectroscopic orbit, the light curve, and high dispersion spectra inside and outside eclipse. The supergiant F-type primary (mass ~ 20$\odot$ $M_v = -8^m\!\cdot\!0$ $R_1 \sim 300\odot$ radii) has normal (solar) abundances (with the possible exception of europium). The primary undergoes an annular eclipse by a slightly smaller and very much fainter body. The spectroscopic changes observed during eclipse are chiefly due to the center to limb variations in the primary. The secondary (mass ~ 7$\odot$ $R_2 = 0.84R_1$) fills its lobe of the critical equipotential surface through the inner Lagrangian point. It may either be a cool supergiant or a hot (subdwarf) star ionizing a small, dense, H II region which produces the eclipse. The high velocity of the system and its great distance from the galactic plane (z = 3.3 kpc) classifies the object as a 'run-away' system. The present state of the system is satisfied by the assumption that the secondary was originally a very massive star (~40$\odot$) and that at some time (~10^7 years ago) it lost most of its mass very rapidly, probably as a result of a type II supernova outburst. The principal numerical data for the system are listed. (auth) (UK)

8912 THE SOLAR SODIUM D LINES. I. PROFILES COMPUTED ASSUMING PURE ABSORPTION. **Finn, G. D.; Mugglestone, D.** Mon. Notic. Roy. Astron. Soc., 137: 221-33 (1967).

On the simple assumption that the sodium D lines are formed in pure absorption, a detailed line-profile analysis is performed, and the resulting theoretical line-profiles are compared with the observed profiles of Waddell. It is found that excellent agreement is obtained, close to the center of the solar disc, in the region of the profile $\Delta\lambda \gtrsim 0.15$ Å for values of sodium abundance and microturbulence close to those derived from previous curve of growth equivalent width analyses. The agreement deteriorates in general as the limb of the Sun is approached. It is found that the assumption of pure absorption is completely inadequate in attempting to describe the core region of the sodium D lines $\Delta\lambda \lesssim 0.15$ Å. The sensitivity of the line-profiles to variations in abundance, microturbulence, and other line-broadening parameters is considered. (auth) (UK)

8913 THE KINEMATICS OF GOULD'S BELT. **Clube, S. V. M.** Mon. Notic. Roy. Astron. Soc., 137: 189-203(1967).

A simple model of Gould's Belt as a projection from the lower edge of the Orion spiral arm is developed, and the radial velocities of the B stars therein analysed for relative solar motion and expansion. The Pleiades group motion is revealed, together with linear expansion in the direction of the galactic center. A brief study of relative proper motions and radial velocities of A stars in Gould's Belt suggests that these have the same kinematic properties as the B stars. The expansion age of Gould's Belt is found to be 3.7×10^7 years, and doubts are expressed as to the extent to which such a system can have influenced the "dynamical equilibrium" of A stars in motions perpendicular to the galactic plane. It would appear that the best estimate of the solar motion with respect to the B-star substratum originating from the spiral arms on either side of the Sun is that obtained by Feast and Shuttleworth (Mon. Notic. Roy. Astron. Soc., 130: 245 (1965)). (auth) (UK)

8914 TEMPERATURES OF CENTRAL STARS OF PLANETARY NEBULAE. **Khromov, G. S.** Mon. Notic. Roy. Astron. Soc., 137: 181-7(1967).

A method is proposed for the investigation of the ultraviolet spectrum of the nuclei of planetary nebulae in the interval 912 to 90 Å. It is based on the data for the relative dimensions of [Ne v], He II, and H I luminosity zones in the nebulae. The optical thicknesses of the nebulae for L_c radiation of hydrogen were estimated from the intensities of the [O I] λλ 6300–6364 lines. The ultraviolet spectra were obtained for six planetary nebulae; in the spectral interval mentioned they appear to be similar to blackbody spectra. The color temperatures of the nuclei are also determined; all are in the range 100,000 to 200,000°K and are higher than appropriate Zanstra temperatures. The linear radii of the nuclei are also extimated. (auth) (UK)

8915 STRATIFICATION OF LUMINESCENCE IN PLANETARY NEBULAE. **Khromov, G. S.** Mon. Notic. Roy. Astron. Soc., 137: 175-80(1967).

The problem of the stratification of luminescence in planetary nebulae is investigated. A criterion is introduced from which it is shown that there are only two luminosity zones in planetary nebulae—He II and [Ne v]—which have corresponding independent Strömgren zones of ionization; in the first case the He III zone, and in the second a "collective" zone due to Ne V, N VI and O VI. A simple method of investigation of the relative densities of the inner regions of planetary nebulae is proposed; the method is based on the relative fluxes in [Ne V], He II, He I and H I spectral lines. (auth) (UK)

8916 THE INFLUENCE OF A MAGNETIC FIELD ON SCHWARZSCHILD'S CRITERION FOR INSTABILITY. **Kovetz, Attay.** Mon. Notic. Roy. Astron. Soc., 137: 169-74(1967).

The conditions which a magnetic field must satisfy in order to be compatible with barotropic, magnetohydrostatic equilibrium are investigated. It is shown that, if the configuration satisfies Schwarzschild's criterion for instability in any region, the magnetic field cannot prevent the onset of convection if it does not cross the boundary of that region. (auth) (UK)

8917 MAGNETIC FIELDS IN THE GALACTIC SPURS. **Bingham, R. G.** Mon. Notic. Roy. Astron. Soc., 137: 157-68 (1967).

The structures of the magnetic fields in the "spurs" of nonthermal galactic radio emission were investigated by making use of the observed polarization and brightness distribution of the radio emission and data on the optical interstellar polarization. In at least two cases the magnetic fields are remarkably well aligned over large areas, and in four cases the field is parallel to the ridge of the corresponding spur. Comparison of the magnetic field direction with the planes of optical interstellar polarization yields an estimated distance of 100 ± 20 pc for the principal ridge of the North Galactic Spur. These facts severely restrict possible theories of these objects. (auth) (UK)

8918 OBSERVATIONS OF H II REGIONS AT 178 MHz. Caswell, J. L. Mon. Notic. Roy. Astron. Soc., 137: 141-50 (1967).

Observations of several H II regions have been made using the Cambridge pencil-beam radio telescope operating at 178 MHz. Contour maps of brightness temperature are presented, which reveal some detail in the structure of the sources. From comparison of the results with those at higher frequency, it is concluded that most of the nebulae are optically thin at 178 MHz; a notable exception is a region of high density in IC 1795, and there is some evidence, though not conclusive, for a similar feature in S 252. (auth) (UK)

8919 HYDROGEN-DEFICIENT CARBON STARS. Warner, Brian. Mon. Notic. Roy. Astron. Soc., 137: 119-39(1967).

Abundance analyses of the five known nonvariable carbon stars with weak hydrogen lines were carried out. With the possible exception of Na, all observable elements heavier than O have normal abundances relative to Fe. Hydrogen is deficient in four of the stars by factors of more than 10^5; in the remaining star a deficiency factor of 50 is found. Carbon is over-abundant by factors of 3 to 10. The similarity of the compositions, space and velocity distributions, and absolute magnitudes of the above stars, the R Cr B variables and the helium stars is stressed. These stars are collectively called hydrogen-deficient carbon (Hd C) stars, and their properties are discussed. They appear to form a class of star entirely different from the normal R and N stars. The continuous opacity in the cool Hd C stars is shown to arise from contributions from He$^-$, C$^-$, electron scattering, Rayleigh scattering by He and C, and photoionization of carbon. It is shown that the number of Fe atoms per gram of stellar material lies in the range 2 to 0.3 times that in the Sun. The Hd C stars are slightly metal deficient, in agreement with their large space velocities. It is suggested that the peculiar abundances of H, C, N and O in these objects arise from loss of outer envelope at a stage shortly after He-burning has started in a star of 1 $M_\odot$. The predicted abundances are then in reasonable agreement with observations, and it appears that most of the O is in the form of ^{18}O. The lifetime of the Hd C stage appears to be $\sim 10^3$ years, in which case secular changes should be observable. The proposed scheme of evolution shows how these helium stars appear as red supergiants and evolve into the white dwarf region of the H–R diagram. (auth) (UK)

8920 THERMODYNAMIC INSTABILITIES IN AN EXPANDING UNIVERSE. Saslaw, William C. Mon. Notic. Roy. Astron. Soc., 136: 39-49(1967).

The stability of perturbations in the thermodynamic parameters of an isotropic expanding Universe which contains matter and radiation in equilibrium is investigated. The possibility that perturbations in the temperature and mean molecular weight may be sufficiently unstable that they could produce important dynamical effects during the thermonuclear and neutralization phases, respectively, is examined and shown to be very unlikely. (auth) (UK)

8921 A SPECTROSCOPIC STUDY OF TWO SOUTHERN β-TYPE VARIABLES. Breger, M. Mon. Notic. Roy. Astron. Soc., 136: 519(1967).

New spectra of the β CMa variable α Lupi taken in 1965 show an outflow of hydrogen relative to He I, and metal lines in nearly all phases. This outflow, however, is found to be smaller by a factor of 3 than the reported outflow in 1960. Futhermore, the velocity amplitude has decreased to about 16 km/s. The velocity of β Cen varies with a very short period of between 3 and $3\frac{1}{2}$ hours (with the amplitude varying between 10 and 20 km/s) as well as with a period which may be more than a year. Together with the spectral type (B2 II) this suggests a β CMa star in a binary system. The extreme width of the spectral lines is unusual for a β CMa star, and the period is very short for such a star. It is postulated that β Cen is intermediate in type between the usual β CMa variables and "normal" B stars. (auth) (UK)

8922 THERMALIZATION EFFECTS IN A ONE-DIMENSIONAL SELF-GRAVITATING SYSTEM. Hohl, F.; Broaddus, D. Tilghman (Langley Research Center, Hampton, Va.). Phys. Lett., 25A: 713-14(Nov. 20, 1967).

For a one-dimensional sheet model of a stellar system it is found that thermalization occurs to the order $N^2\tau_c$ where N is the number of mass sheets in the system and τ_c is the characteristic period for collective motion. (auth)

8923 SOLAR OBLATENESS AND MAGNETIC FIELD. Sturrock, P. A.; Gilvarry, J. J. (Stanford Univ., Calif.). Nature (London), 216: 1280-3(Dec. 30, 1967).

It has been suggested that the observed solar oblateness may be caused by a gravitational quadrupole moment. The answer may not be so simple, however, because of magnetic stress and differential rotation between the radiation layer and the core. (auth) (UK)

8924 SOLAR OBLATENESS AND THE PERIHELION ADVANCES OF PLANETS. Gilvarry, J. J. (Ames Research Center, Moffett Field, Calif.); Sturrock, P. A. Nature (London), 216: 1283-5(Dec. 30, 1967).

Observations of the oblateness of the Sun suggest that it may have a rapidly spinning core. An experiment to test this suggestion, by comparing the perihelion advance of a small artificial planet of high eccentricity and of Mercury, is discussed. (auth) (UK)

8925 GENERATION OF RADIO SOURCES. Burbidge, G. (Univ. of California, San Diego. Univ. of Cambridge, Eng.). Nature (London), 216: 1287-9(Dec. 30, 1967).

Many radio sources have a double character, and high-resolution studies show small components. It is suggested that radio sources may be made up of many small sources. (auth) (UK)

8926 RADIO GALAXIES AS COSMOLOGICAL PROBES. Rowan-Robinson, M. (London Univ.). Nature (London), 216: 1289-92(Dec. 30, 1967).

Applying the luminosity–volume test to radio galaxies, it is found that for the data to fit the usual relativistic cosmological models there must be strong evolutionary factors affecting the distribution of the radio galaxies. The steady-state model is inconsistent with the present data. (auth) (UK)

8927 SOLAR OBLATENESS. Roxburgh, I. W. (London Univ.). Nature (London), 216: 1286(Dec. 30, 1967).

In this article the author answers criticism by Dicke and Goldenberg (Nature, 214: 1294 (1967)) on his theory of why the Sun is oblate. (auth) (UK)

8928 COSMOLOGICAL MODELS CONTAINING BOTH RADIATION AND MATTER. McIntosh, C. B. G. (Univ. of New England, Armidale, Australia). Nature (London), 216: 1297-8(Dec. 30, 1967).

Two types of cosmological models described by Jacobs (Nature 215: 1156(1967)) are discussed. These change from a radiation-like model for early time to a matter-like model for recent time. The radiation in these models is in thermal equilibrium with the matter, and the photons, neutrons, and electrons are not treated separately. (UK)

8929 ORIGIN OF MAGNETIC FIELDS OF STARS AND PLANETS AS A RESULT OF THEIR MATERIAL TURBULENT MOTION. Steenbeck, M.; Krause, F. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 19-44(1967). (In Russian).

A theory for the formation of the magnetic fields of stars and planets is examined. On the basis of the theory a hypothesis is presented on the existence in these cosmic objects of turbulent flow of the ionized mass of the molten internal zone or gaseous material. The results obtained are in good agreement with available astrophysical data. The theory makes it possible to draw some conclusions with respect to the internal structure of stars. (tr-auth)

8930 MEASUREMENTS OF GAMMA RADIATION FROM THE SURFACE OF THE MOON BY THE COSMIC STATION LUNA-10. Vinogradov, A. P.; Surkov, Yu. A.; Chernov, G. M.; Kirnozov, F. F.; Nazarkina, G. B. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geochem. Int. (Engl. Transl.), 3: 707-15(1966).

The intensity and spectral composition of lunar rock γ radiation was investigated with the aid of a γ spectrometer mounted on the automatic station Luna-10. Preliminary results showed that about 90% of the total intensity of lunar rock γ radiation is associated with nuclear reactions induced by cosmic rays and only 10% or less results from the decay of the radioactive elements U, Th, and K contained in lunar rocks. The general level of the γ-radiation intensity over the lunar surface is 1.5 to 2.0 times higher than over terrestrial rocks of the granite type. According to their content of radioactive elements, lunar rocks correspond to terrestrial rocks of basic composition (basalts). (BBB)

8931 PROBLEMS POSED BY PROPERTIES OF THE VELOCITY DISTRIBUTION OF NEAR STARS. Delhaye, J. (Observatoire de Paris, Meudon, France). Bull. Astron. (Paris), 3rd Ser., 2: 21-7(1967). (In French).

Some aspects of the velocity distribution of stars are discussed, especially with regard to the direction of the vertex and ratio of the axes of the velocity ellipsoid. The discrepancies between theory and observation seem to show 2 types of anomaly: one is related to very young stars (B stars) the other to stars of intermediate age (A stars). Recent studies of the kinematic properties of A stars with peculiar spectra help substantiate this point of view and provide data for a model for the interpretation of the velocity distribution of stellar groups made up of stars of different age. (BBB)

8932 EVOLUTION OF SMALL STELLAR SYSTEMS AND THE FORMATION OF DOUBLE STARS. Van Albada, T. S. (Kapteyn Lab., Groningen, Netherlands). Bull. Astron. (Paris), 3rd Ser., 2: 59-65(1967).

Numerical integration of the equations of motion of the N-body problem showed that a random initial structure alters into a hierarchical one with a close binary in the center. The escape process is strongly connected with the formation of binaries due to the tendency to redistribute the binding energy among fewer and fewer stars. It is suggested that this phenomenon may have been operating after the fragmentation of a dense cloud into protostars. In this way it may account for the formation of visual double stars and possibly be connected with the expansion of associations. The accumulation of errors, and the reversibility of the integrations is discussed. (BBB)

8933 OBSERVATIONAL APPROACH TO INTERSTELLAR GAS DYNAMICS. Dixon, M. E. (Univ. of Edinburgh). Bull. Astron. (Paris), 3rd Ser., 2: 29-37(1967).

The kinematic properties of B_0V-B_2V stars differ systematically from those of B_3V-B_8V stars. In particular, the B_0V-B_2V stars have systematically smaller v velocities and systematically larger u velocities than the B_3V-B_8V stars. This conclusion arises from a study of the radial velocities of stars in the range 300 to 3000 parsecs from the Sun. The results suggest that the interstellar medium moves about the galactic center at less than gravitational circular velocity under the influence of nongravitational as well as gravitational forces. According to this view, the nongravitational forces cease to act on material which has condensed to form a star, and for this reason newly formed stars move away from the material in which they were produced. Present data indicate that, in the solar region, interstellar gas cloud velocities lag behind the gravitational circular velocity by about 14 km/sec. (BBB)

8934 COLLISIONLESS METHOD IN STELLAR DYNAMICS. I. Aarseth, S. J. (Cambridge Univ., Eng.). Bull. Astron. (Paris), 3rd Ser., 2: 47-57(1967).

A collisionless representation of the potential due to N interacting mass points is developed from an expansion in spherical harmonics. Corresponding expressions for the force are derived for the first 5 orders and used to integrate the equations of motion numerically for a spherical cluster of constant density with N = 1000. The approximate method gives a r.m.s. deficiency in potential of about 3.7% when compared to the Newtonian values for N = 1000, but deviations in force are less satisfactory and lead to a systematic expansion of the cluster. An external galactic force field is included for the case of plane circular motion and the tidal effect is studied. An improved scheme is proposed for treating large particle numbers numerically by restricting the collisionless procedure to regions where encounters are not important. The 2-zone method seems to be well suited for studying centrally concentrated clusters. (BBB)

8935 PHYSICAL MEASUREMENT IN THE FIELD OF FLUCTUATING PHENOMENA. Senatra, Donatella (Univ., Florence). Geofis. Meteorol. (Genoa), 16: 36-8(Jan.-Apr. 1967). (In Italian).

A quantitative method was developed for relating the results of chemical tests to solar flares and proton eruptions. These chemical tests were developed by Piccardi for investigation of fluctuating phenomena associated with geomagnetic and solar activity. The tests are based on physical–chemical measurements of the state of dispersion in colloidal solutions. The polydisperse colloid constitutes a heterogeneous system, in equilibrium, which is sensitive to electromagnetic variations resulting from solar activity. Recent results have shown correlation of the tests with single solar events, and especially with flares and proton eruptions. The importance of continuous recording of test results is emphasized. The quantitative method proposed would allow for this by measuring electrical capacitance in the colloidal solutions, rather than optical or other methods which might interfere with the stability of the system. Mathematical expressions are derived relating electrical parameters with macroscopic precipitation in the system. (BBB)

8936 SOLAR PARTICLE RADIATION. pp 1-44 of Radiation and Shielding in Space. Haffner, James W. New York, Academic Press, 1967.

The following topics are discussed: (1) historical review, (2) observation of events on the Sun, (3) characteristics of the solar wind, (4) characteristics of solar flare particulate radiation, (5) effects of solar particulate radiation on the Earth, and (6) theories of solar particulate radiation. 99 references. (M.O.W.)

8937 NEW GLOBULAR MASS IN THE CENTRAL REGION OF THE GALAXY. Terzan, Agop (Saint-Michel-l'Observatoire, Basses-Alpes, France). Compt. Rend., Ser. A and B, 265: 734-6(Sept. 25, 1967). (In French).

A new globular mass was photographed by means of radiations of the near infrared in a direction near the center of the Milky Way ($l^{\mathrm{II}} = 356^\circ, 3$; $b^{\mathrm{II}} = +2^\circ, 3$) (tr-auth)

8938 THE RADIO ROTATION PERIOD OF JUPITER. Komesaroff, M. M. (CSIRO, Chippendale, New South Wales); McCulloch, P. M. Astrophys. Lett., 1: 39-41(Nov. 1967).

Linear polarization measurements of the 11-cm radiation from Jupiter in 1963 and 1967 indicate that the rotation period is about 0.5 sec longer than the System-III (1957.0) period. Decametric observations had previously indicated a somewhat similar result. The 11-cm flux density has shown little or no variation since 1963. (auth)

8939 FORCE-FREE MAGNETIC FIELDS OF CURRENT INTEREST. Henriksen, R. N. (Queen's Univ., Kingston, Ont.). Astrophys. Lett., 1: 37-8(Nov. 1967).

Some new solutions to the equations of the force-free magnetic field are given, and it is indicated how one may be relevant to the dynamics of stellar shells. (auth)

8940 THE ABUNDANCE OF IRON IN THE SUN AND THE METEORITES. Cameron, A. G. W. (Yeshiva Univ., New York, Goddard Space Flight Center, New York). Astrophys. Lett., 1: 35-6(Nov. 1967).

It has been a puzzle that the solar corona appears to be overabundant in metals relative to the photosphere, and that, relative to its neighbors, iron is underabundant in the photosphere relative to meteorites by a factor of 4. It is suggested that metals are concentrated in the corona by radiation pressure acting on lines, and that the solar wind has carried away much of the iron in the outer solar convection zone. (auth)

8941 ON THE RELATIVE O/Fe ABUNDANCES IN THE SOLAR CORONA. Beigman, I.; Vainshtein, L. (Lebedev Inst. of Physics, Moscow). Astrophys. Lett., 1: 33-4(Nov. 1967).

It is shown that the relative O/Fe abundance in the solar corona is probably much higher than the presently accepted value. (auth)

8942 IONIZATION AND HEATING OF INTERSTELLAR GAS BY SUPERTHERMAL PARTICLES. Pikel'ner, S. B. (Moscow State Univ.). Astrophys. Lett., 1: 43-6(Nov. 1967).

Simultaneous solutions of the equations governing the ionization and heating of interstellar gas by superthermal particles give the physical conditions of the gas for a variety of densities. The solutions account for Faraday rotation, 21-cm radio emission, low-frequency absorption, and the formation of gas clouds. (auth)

8943 WIDE BANDWIDTH OBSERVATIONS OF THE DECAMETRIC BURSTS FROM JUPITER. Flagg, R. S.; Carr, T. D. (Univ. of Florida, Gainesville). Astrophys. Lett., 1: 47-53(Nov. 1967).

A receiver having a bandwidth of 100 kc was used to obtain high-resolution oscillographic recordings of bursts of both the L and S types from Jupiter at 22.4 Mc. The S bursts were found to have surprisingly steep leading and trailing edges. (auth)

8944 THE EMISSION LINES IN THE ULTRAVIOLET REGION 3140 TO 3500 A OF CH CYGNI, AND RELATED PROBLEMS. Swings, J. P.; Swings, P. (Astrophysical Inst., Liege). Astrophys. Lett., 1: 54-6(Nov. 1967).

The M6 semiregular variable CH Cygni had an outburst in June 1967. The emission lines of the ultraviolet region $\lambda < 3500$ Å are described. General considerations on the importance of this region are outlined. (auth)

8945 INFLUENCE OF SOLAR MOTION TOWARDS THE APEX ON THE CREATION OF ACTIVITY CENTERS. Trellis, M. (Observatoire de Nice). Astrophys. Lett., 1: 57-8(Nov. 1967). (In French).

It is shown that more activity centers are born at heliocentric longitudes near 270°, i.e., at solar regions facing the apex, than at longitudes near 90°; the amplitude of the variations is of the order of 10% around the mean value. (auth)

8946 OBSERVATIONS OF HIGHER-ORDER HIGH-QUANTUM HYDROGEN RECOMBINATION LINES IN SIX H II REGIONS. Williams, D. R. W. (Univ. of California, Berkeley). Astrophys. Lett., 1: 59-63(Nov. 1967).

The radio recombination hydrogen lines 156α, 197β and 225γ were observed in six H II regions. Departures from local thermodynamic equilibrium, found in some of the sources, give rise to lines of both greater and smaller strengths than the predicted values. The 225γ line in M17 was found to be Stark-broadened, from which a value for the electron density is inferred, that agrees well with the expected value. (auth)

8947 DETERMINATION OF BROMINE IN STONY METEORITES BY NEUTRON ACTIVATION. Lieberman, K. W.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Contract AT-(40-1)-2670. J. Geophys. Res., 72: 6279-87(Dec. 15, 1967). (ORO-2670-19).

Eighteen chondrites and seven achondrites were analyzed for Br by thermal neutron activation. Fourteen of the specimens were analyzed in replicate. Br is found to be fractionated among the three types of chondrites: carbonaceous 3.04, enstatite 1.64, and ordinary 0.34 ppM Br. This trend is similar to the depletion pattern found by other investigators for iodine. Br is found to have a higher abundance in the type-I carbonaceous chondrites (atomic abundance of 18.6 relative to Si = 10^6 atoms) than has been predicted by calculations based on theories of nucleosynthesis. Br is not depleted in the howardite—eucrite grouping of achondrites with respect to the ordinary chondrites, in spite of the depletion of alkali elements with which Br is often associated in natural materials. (auth)

8948 NEW COSMOLOGICAL THEORY. Valcovici, Victor. Compt. Rend., Ser. A and B, 265: 398-400(Oct. 2, 1967). (In French).

Two principles of a new cosmological theory are reported. The first principle is that the general form of the Hubble law is too simple to be assumed as valid throughout the cosmos. Secondly, the discovery of quasars and blue galaxies makes it necessary to renounce the homogeneity and the isotropy of the universe. (J.S.R.)

8949 WAVELENGTH DEPENDENCE OF THE BANDWIDTH AND THE DURATION OF TYPE I SOLAR RADIO BURSTS. Elgaroy, O. (Univ. Oslo, Blindern, Norway). Astrophys. Lett., 1: 13-14(Sept. 1967).

The question of how the bandwidth and the duration of storm bursts change with the observing wavelength has not yet been satisfactorily answered. On Nov. 11, 1966, storm bursts were recorded simultaneously between 145 and 165 Mc and between 315 and 335 Mc. From the records the bandwidth of the bursts, defined as the frequency span over which the burst could be discerned from the background continuum, was determined. (W.D.M.)

8950 GENERATION OF COSMIC MAGNETIC FIELDS. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Space Flight Center, New York). Astrophys. Lett., 1: 9-11(Sept. 1967).

It is usually assumed that the time required to build up a galactic-scale magnetic field is comparable with the dissipation time, many orders of magnitude longer than the age of the Universe. However, if a seed field is present in turbulent plasma, turbulence and reconnection will form new flux loops, and hydromagnetic waves will generate an overpressure of cosmic rays which will blow up the flux loops to strengthen the seed field. (auth)

8951 RAZIN EFFECT IN THE SOLAR CORONA AND DETERMINATION OF THE MAGNETIC FIELD AT ONE SOLAR RADIUS. Boischot, A.; Clavelier, B. (Observatoire de Meudon, France). Astrophys. Lett., 1: 7-8(Sept. 1967).

The source of a type-IV burst was located at a large distance from the solar surface, where no effect of the plasma on the propagation of radio waves can occur. The spectrum of the burst shows a sharp low-frequency cutoff which is interpreted as due to the Razin effect. This allows determination of the intensity of the magnetic field, which is found to be 0.5 G at an altitude of 1 solar radius. (auth)

8952 COUNTER-JET IN M87. Arp, H. C. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. Lett., 1: 1-5(Sept. 1967).

Luminous markings have been discovered in M87 which extend in the opposite direction to the well-known jet. Spectra and interference filter photographs show that the light of this counter-jet is primarily O II and Hα emission. The elliptical galaxies in the vicinity of M87 are aligned along the line of the jet and counter-jet. (auth)

8953 INFLUENCE OF THE SATELLITE Io ON JUPITER'S DECAMETRIC RADIO EMISSION. Gopala Rao, U. V. (Kodaikanal Observatory, India). Proc. Indian Acad. Sci., Sect. A, 66: 112-19(Aug. 1967).

An analysis of the influence of the satellite Io on Jupiter's decametric radio emission was carried out utilizing observations recorded at Kodaikanal and Boulder. The influence is found to be complicated and is different at the three sources. It is suggested that the Io related emission can be due to Cherenkov radiation by fast electrons acting as a well-separated stream. (auth)

8954 OBSERVATION OF THE NOVA DELPHINI, 1967. Fehrenbach, Charles; Andrillat, Yvette; Bloch, Marie. Compt. Rend., Ser. A and B, 265: 583-7(Aug. 28, 1967). (In French).

The results of observations made since July 10, 1967 on the Nova Delphini are reported. The spectrum of this novum is very remarkable. It is differentiated from the majority of other novae by the following characteristics: the elements present are few; the emissions are relatively fine with the exception of those of H_2; and the absorptions have a simple structure and only those of Ca II were observed during the observations. No important spectral modifications were observed. (J.S.R.)

8955 DISTANCE TO THE STAR ASSOCIATED WITH SCORPIO XR-1. Wallerstein, George (Univ. of Washington, Seattle). Astrophys. Lett., 1: 31-2(Sept. 1967).

The equivalent widths of the interstellar Ca II lines were measured in the spectrum of Scorpio XR-1 and compared with the five nearby stars. The interstellar lines in Sco XR-1 are stronger than in any of the stars, implying that the distance to Sco XR-1 is greater than 270 parsecs. (auth)

8956 OPTICAL DEPTHS AND ELECTRON TEMPERATURES OF TWO PLANETARY NEBULAE DERIVED FROM THEIR RADIO-FREQUENCY SPECTRA. Thompson, A. R. (Stanford Univ., Calif.). Astrophys. Lett., 1: 25-9(Sept. 1967).

Measured radio flux densities for IC 418 and NGC 6572 are computed on the assumption that the optical depth is proportional to the Balmer line brightness. The values of electron temperature thus derived have large uncertainties but are significantly less than the temperatures derived from forbidden lines. Possible reasons for this difference are discussed. (auth)

8957 LIMITS TO THE NEUTRAL HYDROGEN CONTENT OF ω CENTAURI AND 47 TUCANAE. Robinson, B. J. (CSIRO, Sydney). Astrophys. Lett., 1: 21-3(Sept. 1967).

Twenty-one cm observations of globular clusters with the Australian 210 ft radio telescope set limits to the mass M_H of neutral hydrogen of $20M_\odot$ for ω Centauri and $15M_\odot$ for 47 Tucanae. The hydrogen content M_H/M_T is then less than 5×10^{-5} for ω Cen and 7×10^{-5} for 47 Tuc. (auth)

8958 ON THE NATURE OF P CYG-TYPE STARS. Luud, L. (Inst. of Physics and Astronomy, Tartu). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 16: 319-29(1967). (In Russian).

The nature of P Cyg-type stars is discussed. They are found to be extremely bright supergiants, which lose their mass by pulsational instability. Turbulent motions, chemical compositions and other characteristics of P Cyg-type star atmospheres turn out to be similar to the corresponding characteristics of the normal supergiant atmospheres. (auth)

8959 SOME REMARKS ABOUT STELLAR MAGNETIC FIELDS. Cattani, D. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim. (10), 52B: 574-77 (Dec. 11, 1967).

All observed stellar magnetic fields are time variable. In the problem of the origin of the stellar fields it is very important to establish clearly whether these fields vary in the whole volume of the star or not. To prove that the affirmative case is not possible, the well-known objection of the decay time of a magnetic field and an argument connected with the energy balance in the star are discussed. (W.D.M.)

8960 U, B, V COLORS OF QUASI-STELLAR OBJECTS AND THEIR SPECTRAL-ENERGY DISTRIBUTIONS. Lari, C.; Setti, G. (Univ., Bologna. Osservatorio Astronomico, Rome). Nuovo Cim. (10), 52B: 507-28(Dec. 11, 1967).

Evidence is given that many quasi-stellar objects, about fifty percent, have very curved optical continua in a plot of log F(ν), the emitted flux, against the frequency. The sign of the curvatures appears to be correlated with the red-shift z, so that the general correlation of the U, B, V colors with z has to be interpreted in terms of both the continuum and the emission lines. At the high frequencies the observations are consistent with an exponential-law energy distribution for a typical continuum. There is also some evidence that the general correlation at high values of z could be better interpreted by assuming an asymmetry in the Ly-α line emission. This line may also be responsible for a drastic change in the color indexes of QSO's at $z > 2.3$. An estimate of this effect is given, together with a general discussion of the problems involved. (auth)

8961 COSMIC BLACK-BODY RADIATION AND THE INVERSE COMPTON EFFECT IN THE RADIO GALAXIES: THE X-RAY BACKGROUND. Bergamini, R.; Londrillo, P.; Setti, G. (Univ., Bologna. Osservatorio Astronomico, Rome). Nuovo Cim. (10), 52B: 495-506(Dec. 11, 1967).

An examination is made of some consequences of the inverse Compton effect in the radio galaxies due to the presence of a universal black-body radiation at 3°K. In particular it is shown that the observed x-ray diffuse radiation between 1 keV and MeV may be interpreted as inverse Compton radiation from the strong and extended radio galaxies if this class of sources evolve with z and magnetic fields of a few μG are typically present. The Compton losses, and their relevance to the problem of the radio source spectra, are discussed. It is shown that, if the average magnetic field is within the range 1 to 3 μG, then the radio data point to an interpretation in which the expected breaks in the spectra occur at high frequencies. It is estimated that the particles must escape from the systems in a time of at least $\sim 3 \times 10^6$ years. It is also pointed out that at high red shift the Compton losses become so strong as to drastically reduce the lifetime of the radio sources, so that important cosmological consequences may be expected. (auth)

8962 BALLOON OBSERVATIONS OF COSMIC X-RAY SOURCES. Brini, D. (Univ., Bologna); Ciriegi, U.; Fuligni, F.; Vespignani, G.; Baseggio, A. F. Nuovo Cim. (10), 52B: 482-6 (Dec. 11, 1967).

The results of a balloon flight to search for x-ray sources in the 30- to 200-keV range are reported. From the Crab region, a flux of (0.29 ± 0.06) quanta/cm^{2}s, or 2.8×10^{-8} erg/cm^{2}s, with a power spectrum law of exponent of -2.1 ± 0.2, is found. Another emission from a sky zone located at (08 ± 01) h R.A. and $(60 \pm 10)^\circ$D, was discovered. Assuming a power spectrum law, the exponent results -1.3 ± 0.2, giving a flux of (0.25 ± 0.06) quanta/cm^{2}s corresponding to $3.3 \cdot 10^{-8}$ erg/cm^{2}s. The sky zone including the 1- to 10-keV x-ray sources Cep X1, Cep X2, Cep X3, Cass X1 (A) and Lac X1 was also investigated. The upper limit of the flux is about (0.11 ± 0.06) quanta/cm^{2}s corresponding to less than 10^{-8} erg/cm^{2}s. (auth)

8963 NEUTRON STARS AND NUCLEAR REPULSIVE FORCES AT HIGH DENSITIES. Cazzola, P. (Univ., Ferrara, Italy); Lucaroni, L.; Scarinci, C. Nuovo Cim. (10), 52B: 411-28(Dec. 11, 1967).

An equation of state for nuclear matter at zero temperature and very high densities is proposed under the assumption of a soft repulsive core among baryons. The implications of this hypothesis on the equilibrium mass and radius of the core of a neutron star corresponding to densities larger than 10^{39} baryons/cm^3 are examined. The results are discussed in a more general framework in which equations of state of the type $\rho = kP$ are taken into account. It is found that the "more rigid" equations of state (corresponding to smaller values of k) give rise to larger equilibrium masses and radii. Moreover the soft-core equations may be represented as $\rho = kP$ with k ranging from 1 to 2 depending on the density range. The models lead to a maximum equilibrium mass for the star larger than 1.8 solar masses which is above Chandrasekhar's limit. The astrophysical consequences of this result are briefly examined. (auth)

8964 EXCLUDED-VOLUME MODEL OF A DEGENERATE FERMI GAS OF HARD SPHERES. Barker, B. M.; Bhatia, M. S.; Szamosi, G. (Univ. of Windsor, Ontario). Nuovo Cim. (10), 52B: 355-74(Dec. 11, 1967).

The problem of the equation of state of a zero-temperature Fermi gas of hard spheres is examined using the excluded-volume approximation. The distribution function which minimizes the energy in this approximation is derived exactly. Up to a certain "critical" density, which depends on the mass, spin, and the radius of the hard spheres, the distribution function is similar to that of the zero-temperature ideal Fermi gas but is radically different for densities greater than the critical density. Energy–density, pressure, and the velocity of sound in the system are then calculated. It is found that for hard-sphere radii less than a certain maximum radius r_{max}, which is a function of the mass and the spin of the particles, the velocity of sound is always less than the velocity of light and approaches it in the high-density limit. For special limiting densities, power series expansions for all the relevant quantities are given. The results for energy–density and pressure as obtained are compared with those obtained from (i) the Zel'dovich model (repulsive-vector interaction), (ii) a scalar interaction model, and (iii) the free-particle model. (auth)

8965 THE CIRCULATION OF THE SUN'S ATMOSPHERE. Starr, Victor P.; Gilman, Peter A. Sci. Amer., 218: 100-2; 107-13(Jan. 1968).

Analyses of sunspot motion were made in an attempt to construct a hypothesis to explain how the sun can rotate faster at its equator than it does elsewhere. The hypothesis is similar to the one that accounts for currents such as the high-speed flow of air in the earth's atmosphere known as the jet stream. The analyses are discussed at length. (M.H.R.)

8966 EMISSION OF [0 II] AND [0 III] FORBIDDEN TRANSITIONS BY QUASI-STELLAR OBJECTS. Burgess, D. D. (Imperial Coll. of Science and Tech., London). Nature (London), 216: 1092-4(Dec. 16, 1967).

The observation of forbidden transitions in the emission spectra of quasars has led to the deduction of limiting values for the electron density in relevant regions of these sources. It is shown that significant limits must also be set on the uv radiation intensity in the emitting region, and thus on the size of the region, if the observation of [0 II] transitions are to be explained even at low electron densities. The level scheme relevant to both 0 II and 0 III is depicted, and consideration given to the alteration in the forbidden line intensities produced by photoexcitation to levels connected by allowed transitions to both the metastable states; only the nearest excited level is considered. Collisional depopulation is neglected in comparison with radiative processes, since the interest is in conditions where forbidden transitions are emitted strongly. Spontaneous radiative transitions are assumed to be the only significant processes depopulating the excited level. The ratio of the intensities of any two of the forbidden transitions is obtained from the rate equations for the population levels. The most interesting conclusion is perhaps that there exists in principle at least a means of estimating upper bounds to the distance of such sources independently of their redshifts. The findings of other workers are discussed. (UK)

8967 ABSORPTION LINES IN QUASI-STELLAR OBJECTS. Burbidge, G. R.; Burbidge, E. M. (Univ. of California, San Diego). Nature (London), 216: 1092(Dec. 16, 1967).

It is stated that Gamow's conclusion that the lack of correlation between apparent brightness and red shift of quasars was due to the red shifts being measured from absorption spectra due to galaxies intercepting the light from the more distant quasars, represents a misinterpretation of the observational data. All the red shifts used in the analyses were emission line red shifts, which could not arise other than from the quasar. Whilst it is true that some quasars do show absorption lines, in addition to emission lines, in their spectra, only about 20 of the 104 with known red shifts do so. The absorption line red shifts are found either to be approximately equal to the emission line red shifts, or to have a "standard" value of about 1.95. In cases where $z_{abs} \approx z_{em}$ there is no question but that the emission lines and the absorption lines all arise in the quasar. Where $z_{abs} \approx 1.95$, often $z_{em} > z_{abs}$, or $z_{em} \approx z_{abs}$, but there is at least one case where $z_{abs} > z_{em}$ by a small amount. Spectroscopic arguments strongly suggest that in such a case, also, the regions producing the absorption lines are very close to the source of radiation in the quasar. This, together with the finding of a "standard" red shift, led the authors to the conclusion that the red shifts are largely intrinsic and not cosmological. It has been argued, however, that the "standard" absorption spectrum is caused by galaxies all at this cosmological red shift, leading to the requirement of a cosmological model of the Lemaitre type. In no case, however, do the data support the idea that the absorption takes place in galaxies with a wide range of red shifts. (UK)

8968 COSMIC DISPLACEMENT TOWARD THE RED AND INTERSTELLAR THERMAL RADIATION. Brillouin, Leon Compt. Rend., Ser. A and B, 265: 669-71(Sept. 18, 1967). (In French).

The possibility of collision between the photons one mm in wave length filling interstellar space and the radiation coming from a star is analyzed. The collision mechanism suggested agrees with the de Broglie suggestion on photon aging and makes it possible to distinguish the case of luminous stars from quasars. (J.S.R.)

8969 THE INFLUENCE OF SATURN'S RINGS ON ITS EXOSPHERE AND MAGNETIC FIELD. Zlotnik, E. Ya. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 462-70 (Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 581-92(May-June 1967).

An analysis is made of the motion of ionized gas in Saturn's exosphere induced by a force exerted by the rings perpendicular to the magnetic field. The one-dimensional problem is solved; under certain conditions the dipole magnetic field will be considerably distorted, becoming stronger near the equatorial plane than at a distance of order $R_{♄}$ away. Since the dipole-field strength also increases toward the poles, magnetic traps can be formed in intermediate latitudes, at a height of (1 to 2)$R_{♄}$ from the planet's surface. These traps may contain high-energy electrons responsible for Saturn's radio emission. With the synchrotron mechanism as a basis, experimental radio data can yield information on the physical conditions in the planet's exposure—the strength and configuration of the magnetic field, the density of the medium, and the relative content of the ionized component. (auth)

8970 A SURVEY OF RADIO EMISSION AT 178 MHz. **Caswell, J. L. (Dominion Radio Astrophysical Observatory, Penticton, Can.); Crowther, J. H.; Holden, D. J. Mem. Roy. Astron. Soc., 72: 1-34(1967).**

A pencil-beam radio telescope operating at 178 MHz was used to survey considerable areas of the northern sky; the resolution, about 20′ arc, is better than has previously been used at metre wavelengths. The results are presented as a series of contour maps of sky brightness. (auth) (UK)

8971 FITTING COSMOLOGICAL MODELS TO THE RADIO SOURCE COUNTS. **Davidson, W. (Univ. of Otago, Dunedin, New Zealand). Nature (London), 216: 1076-9(Dec. 16, 1967).**

Inspection of a properly formulated distribution for radio sources of local luminosity shows that the distribution is not as wide as has been thought. The distribution fits a Gaussian curve, with a standard deviation of one, to a good approximation. (auth) (UK)

8972 DO RADIO STARS EXIST? Mackay, C. D. (Cavendish Lab., Cambridge, Eng.). Nature (London), 216: 1091-2 (Dec. 16, 1967).

A new class of radio objects, known as radio stars, has been reported as a result of a search in the positions of 3C(revised) radio sources having $|b^{II}| > 30°$ for which no identification with an optical object had been made. The search led to the discovery of apparent coincidences between the positions of seven radio sources and those of objects with normal stellar spectra and $m_v \lesssim 20$. The present paper describes the results of a study of the positions of these sources, with improved accuracy, using the one-mile telescope of the Mullard Radio Astronomy Observatory at a frequency of 1407 MHz. The distribution of angular structure was found to be very similar to that found in a large sample of 3C sources, most of which are identified with extragalactic objects. It is concluded that while it will never be possible to exclude the hypothesis that certain radio sources are identified with galactic stars, there is no evidence to support it. (UK)

8973 TWOFOLD INCREASE OF THE HIGH-ENERGY X-RAY FLUX FROM CYGNUS XR-1. **Overbeck, James W.; Tananbaum, Harvey D. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 20: 24-7(Jan. 1, 1968).**

In a series of measurements using a balloon-borne scintillation counter a significant change in the high-energy (<23 keV) x-ray flux from Cygnus XR-1 was found. On May 16 and 25, 1967, the same detector was flown and the spectrum of XR-1 was measured from 23 to 97 keV on Sept. 19, 1966. These two May observations were in agreement with each other and were about twice the magnitude of the result reported earlier. (W.D.M.)

8974 PARTICLES AND FIELDS: SIGNIFICANT ACHIEVEMENTS. **Schardt, Alois W.; Opp, Albert G. (National Aeronautics and Space Administration, Washington, D. C.). Rev. Geophys., 5: 411-46(Nov. 1967).**

Space observations during 1964 and 1965 have led to discoveries in the physics of cosmic rays, the solar wind, and the magnetosphere. These results are particularly pertinent to a period of minimal solar activity. A regular sector structure, persisting for many solar rotations, was found to modulate the solar wind and its embedded magnetic field. Energetic protons up to about 10 MeV are emitted continuously from the Sun in streams along certain magnetic field lines that corotate with the sector structure. The solar modulation of the propagation of galactic and solar cosmic rays was studied extensively, and theoretical explanations of this phenomenon have been derived on the basis of a diffusion model. It was discovered that low energy electrons (about 40 keV) are emitted by some solar flares, and substantial progress has been made in measuring the electron component of galactic cosmic rays. The existence of a neutral sheet in the geomagnetic tail has been demonstrated, and substantial progress was made in defining its properties as well as those of the transition region between the solar wind and the magnetopause. A short summary of spacecraft operation in 1965 is also given. (auth)

8975 ON THE ORIGIN OF NOBLE GAS ANOMALIES IN CANYON DIABLO GRAPHITE. **Bennett, J. H.; Manuel, O. K. (Univ. of Missouri, Rolla). Earth Planet. Sci. Lett., 3: 95-100(Nov. 1967).**

Activation analyses on Canyon Diablo graphite show an iodine and uranium content of 337 ± 35 ppb and 108 ± 21 ppb, respectively. The $^{129}I-^{129}Xe$ formation interval for the graphite is calculated and found to agree with the formation intervals reported for stone meteorites. During exposure to cosmic rays the Abee enstatite chondrite is shown to be ≈50 times more effective than Canyon Diablo in producing epithermal neutrons. The ^{86}Kr anomaly in Canyon Diablo graphite and other meteorites is compared to an unexplained ^{86}Kr excess reported in pile-irradiated chondrites. (auth)

8976 NEON, ARGON, KRYPTON, AND XENON COMPOSITIONS OF THE MISTECA AND CARBO IRON METEORITES. **Munk, Miner N. (Univ. of California, Berkeley). Contract AT(11-1)-34. Earth Planet Sci. Lett., 3: 133-8(Nov. 1967). (UCB-34P32-58).**

The neon, argon, krypton, and xenon compositions in the medium octahedrites Misteca and Carbo are reported. A ^{129}Xe component and, to a lesser extent, a ^{131}Xe component in excess of the trapped and spallation components in Carbo xenon were observed. Otherwise the rare gas compositions can be understood in terms of a cosmic-ray spallation component and a trapped component of atmospheric isotopic composition. The same agreement was found earlier between observed and calculated spallation compositions in the Costilla Peak medium octahedrite, and the observed differences in the three meteorites are attributed to different degrees of cosmic-ray shielding. (auth)

8977 PHOTONEUTRINO AND OTHER NEUTRINO PROCESSES IN ASTROPHYSICS. **Petrosian, Vahe. Ithaca, N. Y., Cornell Univ., 1967. 105p.**

Thesis.

The neutrino energy production rate of various processes in a hot plasma is considered. The photoneutrino process is discussed in detail including the position contribution to the energy and the dielectric effects of the plasma on photons. Approximate analytic expressions for the energy production rate for certain limiting cases are derived. The results of a Monte Carlo method of integration of the exact energy production rate are presented by graphs and a rough empirical formula. The energy production rate of the photoneutrino process is compared with the rates of pair-neutrino, plasma-neutrino, recombination neutrino, bremsstrahlung, and photon–photon scattering process. (Disser. Abstr.)

8978 STELLAR EVOLUTION WITH MASS LOSS. **Hartwick, Frederick David Alfred. Toronto, Univ. of Toronto, 1966.**

Thesis.

The object of this investigation was to determine some gross effects of mass loss on stellar evolution. A star of an initial mass of 15 $M_{\odot}$ is evolved from the main sequence, through core hydrogen burning, hydrogen exhaustion, shell hydrogen burning to past the onset of core helium burning. The star is continually losing mass according to a formula given by McCrea. Throughout the evolution the mass loss rate ranges from 5.6×10^{-7} $M_{\odot}$/yr to 1.7×10^{-5} $M_{\odot}$/yr. The mass of the last computed model is 1.168 $M_{\odot}$. The early evolution is compared to that of a 15 $M_{\odot}$ star evolving at constant mass. Near the main sequence, the mass loss star decreases in luminosity and on crossing the Hertzsprung gap, the mass loss becomes so great that the star reverses its rightward motion before reaching the red giant region of the Hertzsprung–Russell diagram. It is concluded that extensive mass loss (1) reduces the ages of clusters that are determined by the turnoff point from the main sequence, (2) broadens the main sequence, and (3) shortens the lifetime of a star in the red giant region of the Hertzsprung–Russell diagram. (Disser. Abstr.)

8979 VOPROSY ASTROFIZIKI. **(Problems in Astrophysics). Porfir'ev, V. V. (ed.). Respublikanskii Mezhvedomstvennyi Sbornik. Seriya Astronomiya i Astrofizika. Kiev, Izdatel'stvo Naukova Dumka, 1967. 148p.**

Separate abstracts were prepared for the fourteen papers included. (W.D.M.)

For abstracts of individual papers see: 8980–8993.

8980 DISTRIBUTION OF THE INTERSTELLAR MATTER AND STARS IN THE REGION WITH CENTER $\alpha = 19^h$, $\delta = 11^0$. Voroshilov, V. I.; Polishchuk, E. P. (Main Astronomical Observatory, Kiev). pp 5-14 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

The distribution of interstellar matter and stars of different spectral types was studied in the region $\alpha = 19^h$, $\delta = +11°$ ($l^1 = 11°$, $b' = 0$) with area equal to about 16 square degrees. Very dense dust clouds with coefficient of an absorption about 20 mag/kpc were discovered. The distance of outward border of the Sagittarius arm equal to 1650 pc was determined from BO-B2 stars in this direction. The regions of the higher density of B8-A1 stars were discovered at the distances of 400 and 600 pc. The luminosity function was constructed from all stars in this region. (auth)

8981 PHOTOELECTRIC PHOTOMETRY OF DY PEGASI. Karetnikov, V. G.; Medvedev, Yu. A. (Odessa State Univ.). pp 15-27 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

Five hundred and ten photoelectric observations of DY Pegasi were obtained on the system close to B−V. Shape and parameters of the light curve were found to be variable. These variations correlate with the secondary period. Color-index varied from $+0^m.14$ to $+0^m.42$. The brightness of maximum depends on the amplitude in the blue light. (auth)

8982 RANDOM AND STATIONARY CHARACTER OF LIGHT CHANGES OF IRREGULAR AND SEMIREGULAR VARIABLES. Lukatskaya, F. I.; Polishchuk, G. A. (Main Astronomical Observatory, Kiev). pp 28-34 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

The results are given of autocorrelation and spectral analyses of light curves for four irregular and one semiregular variable stars. Large and prolonged sequences of observations were used. Autocorrelation functions thus obtained may be regarded as approximate ones. The analysis was carried out partly overlapping for two consecutive intervals of time. (auth)

8983 SPECTROPHOTOMETRIC INVESTIGATION OF NOVA HERCULIS, 1963. Pugach, A. F. (Main Astronomical Observatory, Kiev). pp 35-43 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

Results of reduction of the nova's spectrograms and photographic plates are given. The spectrograms show some anomalies in energy distribution in the spectrum of the star. The photographic magnitudes, spectrophotometric gradients, and equivalent widths of strong emission lines are obtained. (auth)

8984 MERIDIONAL CIRCULATION AND ROTATION LAW FOR BINARY STAR COMPONENTS. Porfir'ev, V. V. (Main Astronomical Observatory, Kiev). pp 44-8 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

Rotation law for components of eclipsing binaries is discussed. A law with equatorial deceleration is shown to be valid in this case. (auth)

8985 ACOUSTIC ENERGY ABSORPTION IN THE HIGH SOLAR ATMOSPHERE. Shul'man, L. M. (Main Astronomical Observatory, Kiev). pp 49-56 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

As both chromosphere and corona are optical transparent mediums, sound waves are subjected to strong absorption due to the radiative relaxation. Considering this process it is shown that transformation of sound waves into shocks can take place only at altitudes lower than (4 to 5) × 10^3 km. The different layers of atmosphere are heated by different regions of the acoustic spectrum because of dependence of the absorption coefficient from the frequency. The conclusion is that structure of the upper atmosphere of the Sun (and a star generally) is determined not only by total flux of energy generated in the convective zone but its spectral distribution as well. (auth)

8986 EFFECTIVE TEMPERATURE OF THE SHOCK WAVE OUTFLOWING TO THE STELLAR SURFACE. Klimishin, I. A. (Lvov State Univ.). pp 57-64 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

An expression is written for the discontinuity of the temperature in the front of a quasi-stationary shock wave when it outflows to the stellar surface, radiative energy losses being taken into account. On the basis of absorptional properties of stellar matter the conclusion is made that the effective temperature in the front of the shock wave does not exceed 12,000°, being independent of the wave-strength. (auth)

8987 DEPENDENCE OF THE SOURCE FUNCTION ON THE TYPE OF ABSORPTION COEFFICIENT. Kostik, R. I. (Main Astronomical Observatory, Kiev). pp 65-73 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

Previously, determination of the astrophysical source function $B_{(\tau)}$ was reduced to the integral equation $B_{(\tau)} = \lambda/2 \int_0^{\tau_0} K(t - \tau) B(t)dt + g(\tau)$, where λ is the probability of the quantum retention in elementary scattering. An attempt is made here at resolving the above equation, considering Doppler and Voigt coefficients of absorption for various distributions of excitation sources in the media. (R.V.J.)

8988 WAVE MOTION IN THE REGIONS OF CONTINUOUS EMISSION STRIPS. Gurtovenko, E. A. (Main Astronomical Observatory, Kiev). pp 74-90 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

Effects similar to the continuous emission strips found by Severnyi in regions of plages and flares were observed in zones of single stable filaments. Main regularities of the shifts of the lines in these regions and their connection with the continuous emission strips were found to be the same as the effects of granulation and motions in the solar photosphere. The strips of continuous emission are due to the same granulation inhomogeneities but on a greater scale. It is supposed that photospheric fluctuations of brightness (granules, continuous emission strips) cannot be explained satisfactorily either by the effect of the rise of overheated gas or by the elementary model of sound waves in the solar photosphere. (auth)

8989 HYDROGEN AND CALCIUM RADIATION OF THE CHROMOSPHERIC FLARES. Kurochka, L. N.; Ostapenko, V. A. (Kiev State Univ.). pp 91-5 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

Photometry of 50 flares in H and Ca II lines across the dispersion were carried out. It was established that the surface brightness maxima in these lines coincide independently of the class of flare, stage of its developments and situation on the solar disk. It can be concluded that hydrogen and ionized calcium radiate in the same volumes. (auth)

8990 CURVE OF GROWTH FOR THE FLARE. Polupan, P. N. (Kiev State Univ.). pp 96-107 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

Some physical characteristics of the flare on the solar disk observed on July 12, 1961, were determined by means of emission curves of growth. The emission lines of neutral iron were investigated in the region of spectrum from 6593 to 3441 Å. One hundred and thirty-seven unblended lines were selected for which the strength of oscilators were known. The equivalent width and central intensities of these lines were used for the construction of the experimental curves of growth. The modification curve of growth was taken as a curve of comparison. It was compared with the corresponding experimental curve of growth and optical thicknesses in the center of each line, Doppler halfwidth, preliminary temperature of the excitation, and quantity of the atoms in the ground state were found. The last two parameters were made more accurate using universal and corresponding experimental curves of growth. (auth)

8991 THE SCATTERING OF THE SOLAR LYMAN-α RADIATION IN THE CHROMOSPHERIC FILAMENT. Yakovkin, N. A.; Zel'dina, M. Yu. (Kiev State Univ.). pp 108-22 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

The equation of the diffusion of solar Lyman-α radiation in a plane-parallel layer of optical thickness 10^5 is solved. The Voigt contour of the absorption coefficient is assumed. The source function is found both in the approximation of the complete redistribution in frequency and in the case without the redistribution. In the first case there is the maximum of the source function near the photosphere. In the second—the dependence of the source function on the optical depth is linear. Independent of situation on the solar disk, the contrast of the filament in both cases is 30%. (auth)

8992 INVESTIGATION OF METAL COMPONENT IN THE BRIGHT PROMINENCE OF SEPTEMBER 18, 1960. Morozhenko, N. N.; Smotrelkina, V. V. (Main Astronomical Observatory, Kiev). pp 123-37 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

Na (D_1,D_2), Mg (λ5184, λ5172), Sr II (λ4078), and Fe (λ5169) spectral lines of a bright prominence were defected. A more exact and simple method reported by Kostik was used for reduction. Electron temperatures of metal filaments were found using lines of ionized iron. Comparing observed and computed degree of ionization for sodium and magnesium, the electron density was found.

8993 SPECTROPHOTOMETRY OF THREE BRIGHT PROMINENCES. Sergeeva, A. N. (Kiev State Univ.). pp 138-46 of Voprosy Astrofiziki. Porfir'ev, V. V. (ed.). Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

The results are given of the standard processing of the spectral observations of the prominences. The prominences were observed with the help of the mirror diffraction spectrograph (f = 6m). (auth)

Atomic and Molecular Physics

Refer also to abstracts 8417, 8423, 8435, 9427, 9450, 9467, 9476, 9478, 9724, and 9904.

8994 (TID-24203, pp 1-3) MOLECULAR COLLISIONS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Angular distribution curves are given for cesium and potassium beam scattering on SO_2. (M.O.W.)

8995 THEORY OF ELECTRON-ATOM COLLISIONS. Veldre, V. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 3-9(1967). (In Russian).

A survey of the work carried out by the Theoretical Branch of the Institute of Physics of the Academy of Sciences of the Latvian SSR on the theory of electron–atom collisions is presented. The following problems are discussed: Electron collisions with hydrogen atoms — (a) variation principles, (b) strong coupling method, (c) effective range theory, (d) electron collisions with highly excited hydrogen atoms, and (e) electron collisions with hydrogen-like ions; (2) electron collisions with alkali metal atoms; (3) electron collisions with inert gas atoms — (a) electron collisions with helium atoms; and (b) electron collisions with neon and argon atoms; and (4) atom ionization by electrons. (auth)

8996 A MEASUREMENT OF THE CROSS SECTION FOR PROTON PRODUCTION IN COLLISIONS BETWEEN ELECTRONS AND H_2^+ IONS. Dance, D. F.; Harrison, M. F. A.; Rundel, R. D.; Smith, A. C. H. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Proc. Phys. Soc. (London), 92: 577-88(Nov. 1967). (CLM-P-149).

A crossed-beam method was used to measure the cross section for proton production in single collisions between H_2^+ ions and electrons at incident electron energies from 5.0 to 1000 eV. The measured cross section is the sum of the dissociative excitation cross section plus twice the dissociative ionization cross section. Its magnitude is in good agreement with other experimental data and with theory, but there is some disagreement over the rate of fall-off of the cross section at high energies. The present data at electron energies above 40 eV can be represented approximately by $Q = (255/E) \log (E/13.8)$ where Q is in units of πa_0^2 and E is in eV. The measured cross section was found to be independent of ion-source pressure over a wide pressure range, and the implications of this with regard to the vibrational-state population distribution of the H_2^+ ions are discussed. (auth) (UK)

8997 EXCITATION OF HELIUM, NITROGEN, AND NITRIC OXIDE BY FAST PROTONS AND HYDROGEN ATOMS. Robinson, J. M.; Gilbody, H. B. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 92: 589-601(Nov. 1967).

Excitation of helium, nitrogen, and nitric oxide by 60- to 400-keV protons and fast hydrogen atoms was studied by the spectroscopic analysis of radiation emitted in the spectral range 3900 to 6000 Å during the spontaneous decay of excited products of single collisions. Absolute cross sections for the emission of some of the more intense lines were determined and, in the case of helium, excitation functions for the 4 ^1S, 5 ^1S, 4 ^1D levels were obtained by the use of known transition probabilities. (auth) (UK)

8998 LOW-ENERGY ELECTRON SCATTERING BY ATOMIC HYDROGEN. II. THE CORRELATION METHOD. Taylor, A. Joanna; Burke, P. G. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 92: 336-44(Oct. 1967).

Previous work for S-wave scattering of electrons by atomic hydrogen calculated with a correlation method is extended to higher partial waves. The wave function used is more flexible than that with which earlier results were obtained. With the use of the bound principle, which is satisfied by this method, cross sections are found for the 1s–2s and 1s–2p transitions in the electron–hydrogen-atom system in the energy region between n = 2 and n = 3 thresholds, which appear to have converged. These cross sections can serve as normalization values for experimental results. Comparison with close-coupling results obtained with expansions including three and six states shows that, in the energy region concerned, both these methods are acceptable. A new shape resonance in the ^1P wave just above the n = 2 threshold is reported. (auth) (UK)

8999 LOW-ENERGY ELECTRON SCATTERING BY ATOMIC HYDROGEN. III. COMPARISON OF THEORY AND EXPERIMENT FOR THE ELECTRON-INDUCED EXCITATION OF HYDROGEN TO THE n = 2 LEVEL. Burke, P. G. (Atomic Energy Research Establishment, Harwell, Eng.) Taylor, A. Joanna; Ormonde, S. Proc. Phys. Soc. (London), 92: 345-50(Oct. 1967).

The results for transitions between the n = 1 and n = 2 states of atomic hydrogen obtained in previous papers are folded with the appropriate electron energy distributions and compared with experiment. Good agreement is obtained with the shape of all the cross sections, with the normalization of the 1s–2p cross section, and with the ratio of spin exchange to total 1s–2s cross section, but the theoretical result for the 1s–2s cross section is a factor of 2 greater than that obtained by the normalization of the experiments to the Born approximation above 300 eV. It is suggested that the use of the theoretical results given in the previous papers may be a preferable way of normalizing the experimental data. Results are given for the polarization of the Lyman α radiation induced by electron impact close to threshold. (auth) (UK)

9000 LOW-ENERGY ELECTRON SCATTERING BY ATOMIC HYDROGEN. IV. THE EFFECT OF RESONANCES ON EXCITATION IN e^-–H SCATTERING. Macek, J.; Burke, P. G. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 92: 351-64(Oct. 1967).

The ^1S, ^3S, ^1P, ^3P, and ^1D partial cross sections for e^-–H scattering given in preceding papers are analyzed using many-channel resonance theory. Partial widths, resonance positions, and the background scattering matrix are obtained. The peak at 11.5 eV in the 1s–2s excitation cross section is shown to follow from interference of resonant and nonresonant processes. This interference is examined in detail and is shown to imply that the scattering matrix can be simplified by transforming it to a representation that diagonalizes the long-range $1/r^2$ potentials coupling the degenerate n = 2 states. The scattering matrix in this representation is obtained, and it is found that the resonance states decay into the same linear combination of state at the n = 2 threshold as are excited from the ground state. Some general results in multichannel resonance theory, applicable to such situations, are proved. The origin of the ^1P H^- autoionizing state at 10.24 eV is discussed, and its position and width are obtained. (auth) (UK)

9001 LOW-ENERGY ELECTRON SCATTERING BY ATOMIC HYDROGEN. V. PHOTOIONIZATION OF H^- IN THE VACUUM ULTRAVIOLET. Macek, J. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Phys. Soc. (London), 92: 365-9 (Oct. 1967).

The photoabsorption coefficient of H^- in the region from 0.65 to 3.5 Ry is calculated using a three-state close-coupling approximation for the final state. Particular attention is given to the region near 0.751 Ry, where a narrow shape resonance exists. Its oscillator strength is estimated to be 0.044. The contributions of processes leaving the hydrogen atom in an n = 2 excited state are studied and are found to contribute 17% of the total. The oscillator strength sum rule is checked within 3%. (auth) (UK)

9002 LOW-ENERGY ELECTRON SCATTERING BY ATOMIC HYDROGEN. I. THE CLOSE-COUPLING APPROXIMATION. Burke, P. G. (Atomic Energy Research Establishment, Harwell, Eng.); Ormonde, S.; Whitaker, W. Proc. Phys. Soc. (London), 92: 319-35(Oct. 1967).

The results of a six-state close-coupling calculation of low-energy electron scattering by atomic hydrogen are presented. The first six hydrogen-atom eigenstates are retained in the expansion of the total wave function, and the resultant equations solved on a CDC 6600 computer. Resonances are found below the n = 3 excitation threshold of atomic hydrogen, and they are shown to play an important role in the excitation cross sections Q(1s–2s) and Q(1s–2p). For energies insufficient to excite these resonances it is found that the three-state close-coupling approximation gives reliable results. Cross sections are given for the transitions between the n = 1 and 3 and the n = 2 levels of atomic hydrogen as well as for elastic scattering on the ground state. (auth) (UK)

9003 DEFORMATION OF SURFACES SPUTTERED UNDER ION BOMBARDMENT. Kalmykov, B. M.; Ryzhov, Yu. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 2, 132-4(Mar.-Apr. 1967). (In Russian).

The mass removal rate by ion bombardment is determined by the sputtering coefficient S (atoms/ion), which is equal to the number of atoms removed per bombarding ion. The available experimental data show that S depends strongly on the angle of incidence ϕ on the surface. The change in surface form of a homogeneous and isotropic body under ion bombardment is calculated. It is shown that the bombarding ions tend to level out the surface. At a bombarding angle $\phi = 40°$ a tendency to form slits is noted. Possible errors in determining the mass removal rate as a function of incidence angle are pointed out. (TTT)

9004 TIME-OF-FLIGHT VELOCITY ANALYSIS OF ATOMIC AND MOLECULAR BEAMS. Hagena, Otto F.; Varma, Ashok K. (Univ. of Virginia, Charlottesville). Rev. Sci. Instrum., 39: 47-52(Jan. 1968).

A systematic analysis of the time-of-flight (TOF) method for measuring the distribution of speeds in molecular beams is presented. The conditions required for resolving a given beam speed distribution are evaluated by calculating the TOF signal for a finite open time τ of the beam shutter. The halfwidth of the TOF signal Δt exceeds the ideal half width Δt^0(for $\tau \rightarrow 0$) by not more than 2.5%, if the resolution $R = \Delta t/\tau$ is equal to or larger than 5. The peak signal amplitude Um is not less than 0.8 U_0/R, where U_0 is the signal corresponding to the unchopped beam ($\tau \rightarrow \infty$). Design criteria for beam chopper and detection system are discussed in terms of the resolution, the range of speeds to be measured, and the optimum signal-to-noise ratio. A TOF system used for the detection of high-intensity molecular beams with large speed ratio, as well as for low-intensity scattered beams, is described and typical experimental results are presented. (auth)

9005 MULTI-PHOTON ABSORPTION IN MONATOMIC GASES. Morton, V. M. (Central Electricity Research Labs., Leatherhead, Eng.). Proc. Phys. Soc. (London), 92: 301-10 (Oct. 1967).

A theoretical discussion of the ionization of an atom by the simultaneous absorption of many photons is presented. This process may be relevant to the production of plasmas by concentrated beams of intense radiation from lasers. Approximate methods are developed for evaluating the quantum-mechanical expression for the ionization probability. It is shown that the r. E form of the interaction Hamiltonian is greatly preferable to the p. A form. Comparison of the numerical results with experiment shows that at moderate pressures this process can at best only provide the initiating electron, and the growth of the plasma must then take place by other means, for example inverse bremsstrahlung. Even to sustain this argument it is necessary to assume that the radiation is normally incoherent, and the role of inhomogeneities in increasing the overall ionization probability is stressed. At low pressures, where this second process is inhibited, better agreement is found. The enhancement of the ionization probability which occurs when a natural atomic level lies close to an integral number of photon energies above the ground state is illustrated by a specific example (lithium). A fourfold drop in the threshold flux for ionization is predicted when a ruby laser is tuned through such a resonance. (auth) (UK)

9006 THE POLARIZATION OF A CLOSED-SHELL CORE OF AN ATOMIC SYSTEM BY AN OUTER ELECTRON. I. A CORRECTION TO THE ADIABATIC APPROXIMATION. Eissa, H.; Opik, U. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 92: 556-65(Nov. 1967).

A simple approximation is proposed for investigating the failure of an atomic closed-shell core to follow adiabatically the motion of an outer electron in an almost nonpenetrating orbital, on the condition that the outer electron has insufficient energy to excite the core. The method is variational and provides approximate upper limits to the nonadiabatic corrections to the energy levels. Calculations are made on the ^2F levels of Na and K and on the ^2F and ^2G levels of Mg^+ and Ca^+. The correction is found to decrease the magnitude of the energy change due to dipole polarization by 6% in the ^2F levels of K and somewhat more in the ^2F levels of Ca^+; for lighter ions, and also for ^2G levels, the percentage changes in the dipole polarization energies are smaller. The effect of the correction on quadrupole polarization is greater, but the calculations are much less accurate. (auth) (UK)

9007 THE POLARIZATION OF A CLOSED-SHELL CORE OF AN ATOMIC SYSTEM BY AN OUTER ELECTRON. II. EVALUATION OF THE POLARIZABILITIES FROM OBSERVED SPECTRA. Opik, U. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 92: 566-72(Nov. 1967).

The dipole polarizabilities of four closed-shell ions, Na^+, Mg^{2+}, K^+ and Ca^{2+}, are evaluated from observed spectra, using theoretical values of the quadrupole polarizabilities taken from the literature and including a number of corrections, in particular a nonadiabatic correction and perturbation corrections up to the fourth order. These additional, previously neglected, corrections are partly positive and partly negative, and nearly cancel each other; consequently the results, in which the probable error is about 1%, are close to results previously obtained from observed spectra. (auth) (UK)

9008 A SIMPLE METHOD FOR CALCULATING VAN DER WAALS INTERACTIONS. Opik, U. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 92: 573-6(Nov. 1967).

A new formula is derived for the dipole–dipole term in the van der Waals interaction between two spherically symmetrical atoms. The approximation consists in taking the distortion of each atom in the instantaneous dipole field of the other atom to be proportional to the corresponding adiabatic distortion, and the coefficients of proportionality are variationally determined. Good agreement with the results of other calculations is obtained in a number of cases involving atomic hydrogen and the inert gases. (auth) (UK)

9009 CALCULATION OF CLASSICAL DIFFERENTIAL SCATTERING CROSS SECTIONS. Flannery, M. R. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 92: 551-5 (Nov. 1967).

The inaccuracy inherent in computing classical differential scattering cross sections by the use of numerical differentiation is removed. The cross section is represented by an analytic form of the derivative, capable of being evaluated to any desired degree of accuracy. The general method is demonstrated for scattering by a Langevin field, and the results are compared with an incremental procedure adopted by previous authors. (auth) (UK)

9010 CONVERGENCE OF ITERATION–VARIATION METHODS FOR ATOMIC SCATTERING PROBLEMS. Sheorey, V. B. (University Coll., London). Proc. Phys. Soc. (London), 92: 531-8(Nov. 1967).

A one-parameter iteration–variation method is developed and used to calculate phase shifts for scattering by model potentials. Some reasons are suggested for the failure to obtain convergence in certain energy ranges. Alternative iteration–variation methods are proposed and some typical numerical results are given. (auth)

9011 INFLUENCE OF BACK-COUPLING AND DISTORTION IN A CHARGE-EXCHANGE REACTION. Macomber, H. K.; Webb, T. G. (GCA Corp., Bedford, Mass.). Contract AF29(601)-7093. Proc. Phys. Soc. (London), 92: 839-40(Nov. 1967).

Calculations were performed to examine the effects of back-coupling and distortion in the asymmetric reaction $He^{2+} + H(1s) \rightarrow He^+(1s) + H^+$. It is shown that back-coupling is not important at α-particle energies above 100 keV and that the approximation to the distortion used by McCarroll and McElroy (Proc. Roy. Soc., 266: 422-8(1962)), leads to incorrect cross sections. (auth) (UK)

9012 L EMISSION SPECTRUM OF LUTETIUM. Deodhar, G. B.; Singh, R. B.; Varma, P. P. (Univ. of Allahabad, India). Proc. Phys. Soc. (London), 92: 826-9(Nov. 1967).

The L emission spectrum of lutetium was investigated using a 40 cm bent-crystal spectrograph of the transmission type. The existence of the lines λ1193.95 x.u. and λ1143.92 x.u., corresponding to the non-quadrupole transitions $L_I N_I$ and $L_I O_I$ respectively, and a line λ1138.88 x.u., corresponding to the quadrupole transition $L_I O_{IV,V}$, was established for the first time. The transitions $L_{III} N_{IV}$, $L_{III} O_{IV,V}$, $L_I N_{IV}$, $L_I N_V$, $L_{II} O_{II,III}$ and $L_{III} O_{II,III}$ reported earlier by Allais were confirmed. The lines λ1772.3 x.u. and λ1530.2 x.u., corresponding to the transitions $L_{III} M_{II}$ and $L_{II} M_{II}$, respectively, could not be confirmed. (auth) (UK)

9013 $2'$-POLE SUM RULES FOR THE HYDROGEN ATOM. Bell, R. J. (National Physical Lab., Teddington, Eng.). Proc. Phys. Soc. (London), 92: 842-4(Nov. 1967).

A recurrence formula is derived which gives the $2'$-pole oscillator strength sums for atomic hydrogen for negative integral powers of the energy. This is accomplished by solving a differential equation formulated by Dalgarno and Lewis (Proc. Roy. Soc., A233: 70-4(1955)). (auth) (UK)

9014 A REMEASUREMENT OF THE $L\alpha_{1,2}$ LINES OF PRASEODYMIUM. Gokhale, B. G.; Shukla, S. N. Proc. Phys. Soc. (London), 92: 521-2(Oct. 1967).

The $L\alpha_{1,2}$ lines of praseodymium were remeasured using a 40 cm curved mica crystal spectrograph of the transmission (Cauchois) type. In common with the trend observed by earlier workers for other rare-earth elements, the values of the wavelengths (Pr $L\alpha_1$ = 2457.99 x.u., Pr $L\alpha_2$ = 2468.10 x.u.) obtained in the present investigation are a few tenths of one x-ray unit greater than those reported by Hjalmar. (Z. Phys, 7: 341-50(1921). (auth) (UK)

9015 A VARIATIONAL FUNCTION FOR THE GROUND STATE OF H_2^+. Bhalla, K. C.; Khubchandani, P. G. (Bhabha Atomic Research Centre, Bombay). Proc. Phys. Soc. (London), 92: 529-30(Nov. 1967).

For the ground state of H_2^+ the function $\psi = (1 + pR\xi) \exp(-\alpha R\xi) \cosh(\beta R\eta)$ which is separable into elliptic coordinates, was studied. The calculated energy is lower than that of any of the existing variational functions. The integrals $\langle X^2 \rangle$ and $\langle Z^2 \rangle$, as well as the energy values for different nuclear separations, were also calculated. (auth) (UK)

9016 THE TRIPLET S STATES OF THE HELIUM ISOELECTRONIC SEQUENCE. Cohen, M.; McEachran, R. P. (York Univ., Toronto). Proc. Phys. Soc. (London), 92: 539-42(Nov. 1967).

A matrix method is used to calculate the energy eigenvalues and the corresponding orbital wave functions for a number of ^3S states of the helium isoelectronic sequence within the framework of the "fixed core" approximation. The wave functions are employed to calculate the expectation values of a number of one-electron operators. Results are presented for the 2 ^3S, 3 ^3S and 4 ^3S states of He, Li^+ and Be^{2+}. (auth) (UK)

9017 ON THE HARTREE-FOCK EQUATIONS FOR THE EXCITED SINGLET S STATES OF HELIUM-LIKE IONS. Sharma, C. S. (London Univ.). Proc. Phys. Soc. (London), 92: 543-50 (Nov. 1967).

Hartree–Fock integro-differential equations for the excited singlet S states, and in particular for the 1s2s ^1S state, of helium-like ions are studied by the examination of the first-order equations in a perturbation expansion in powers of 1/Z; the complete set of hydrogenic eigenfunctions for $\underline{s}$ orbitals is used as the basis for the solution of these equations. The statement of a theorem due to Froese (Astrophysics J. 141: 1206-21(1965)) is shown to be in error and is corrected. Considerable insight into the roles of various zero-order states in the first-order function, and the effect of various constraints on these, is gained. It is shown that, for the nsms ^1S state, the zero-order ns^2 ^1S and ms^2 ^1S states play a very important part in determining the effect of the constraints on the first-order Hartree–Fock functions. (auth) (UK)

9018 ELECTRON CAPTURE FROM HYDROGEN AND HELIUM BY μ^+ MESONS. Moussa, A. H.; Abdel-Monem, M. S. (Ain Shams Univ., Cairo). Proc. Phys. Soc. (London), 92: 370-6(Oct. 1967).

The Born approximation is used to calculate the cross sections for capture of electrons from hydrogen and helium atoms by positively charged mu mesons. It is found that for low energy the cross section exceeds values for the corresponding capture processes by protons. This shows that chemical reactions involving mu mesons are of considerable importance, and supports the conclusion by Nosov and Yakovleva (Soviet Phys., JETP, 16: 1236-46(1963) and Nucl. Phys., 68: 609-31(1965)) in their treatment of depolarization of μ^+ mesons in matter. (auth) (UK)

9019 CLASSICAL ADIABATIC PERTUBATION THEORY OF ATOMIC EXCITATION. Percival, I. C. (Univ. of Stirling, Scotland); Richards, D. Proc. Phys. Soc. (London), 92: 311-18(Oct. 1967).

In the general classical theory of collisions of electrons and protons of charge ±e and velocity v with hydrogen atoms at rest, classical impulse and Monte Carlo methods apply to ionization and charge transfer. For very weak excitations and intermediate incident particle energies, however, classical adiabatic perturbation theory is preferable. In this limit the differential cross section with respect to energy transfer ΔE is $[d\sigma/d(\Delta E)] = (E/U|\Delta E|)\,(m_e/m_i)\ln[|8U^2m_i/E\,\Delta E\,m_e\sqrt{e}|]\pi a^2$ where U is the initial binding energy of the electron (mass m_e), m_i is the mass of the incident particle, and a the semi-major axis of the orbit. The theory may be applied only to fairly highly excited quantum states. Regions of validity of the approximation and corresponding quantum cross sections are obtained. (auth) (UK)

9020 PHOTON ATTENUATION CROSS SECTION OF URANIUM. Perkin, J. L.; Douglas, A. C. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Proc. Phys. Soc. (London), 92: 618-21(Nov. 1967).

Measurements of the attenuation cross section of uranium were made for photons of eleven discrete energies in the region 10 to 300 keV in order to resolve large discrepancies between two previously published estimates of this cross section. The present results lie between these estimates and agree with some other recent experimental work. They are also in good agreement with the sum of the photoelectric, coherent scattering and incoherent scattering partial cross sections obtained from theoretical calculations. (auth) (UK)

9021 PHOTOIONIZATION CROSS SECTIONS FOR ATOMIC OXYGEN. Henry, Ronald J. W. (Kitt Peak National Observatory, Tucson, Ariz.). Planet. Space Sci., 15: 1747-55(Nov. 1967).

Photoionization cross sections for ground-state atomic oxygen are presented for wavelengths longer than 25 Å. Multichannel expressions, in the dipole approximation, are used to calculate cross sections for the ejection of an outer subshell electron. The effect of coupling between final state channels is to bring the dipole velocity and dipole length forms of the cross sections into closer agreement. Single-channel expressions, in the dipole approximation, are used to calculate cross sections for the ejection of an inner subshell electron. For wavelengths shorter than 665 Å total cross sections, calculated in the dipole length approximation, agree with experiment. Photoionization cross sections, for ejection of an outer subshell electron from atomic-oxygen in states ^1D and ^1S, are presented for wavelengths longer than 150 Å. (auth) (UK)

9022 ENERGY DEPENDENCE OF REACTIONS O^+ WITH N_2 AND O_2. I. DRIFT TUBE MEASUREMENTS. Bohme, D. K.; Ong, P. P.; Hasted, J. P. (University Coll., London). Planet. Space Sci., 15: 1777-80(Nov. 1967).

In discussing the theory of the F-region of the atmosphere it is necessary to know the rate coefficients for those reactions which convert atomic ions into molecular ions. Rate constants for $O^+ + O_2 \rightarrow O_2^+ + O$, and $O^+ + N_2 \rightarrow NO^+ + N$, were measured with the drift tube technique, using ground state O^+ ions. The energy variation for the former is slight from 0.07 eV (2×10^{-11} cm^3 sec^{-1}) to 0.2 eV (3×10^{-11} cm^3 sec^{-1}) but it rises almost linearly with energy to 9×10^{-10} cm^3 sec^{-1} at 20 eV. The rate for the latter reaction rises almost linearly with energy from 7×10^{-12} cm^2 sec^{-1} at 0.07 eV to 3×10^{-10} cm^3 sec^{-1} at 10 eV. (auth) (UK)

9023 ENERGY DEPENDENCE OF REACTIONS OF O^+ WITH N_2 AND O_2. II. AFTERGLOW MEASUREMENTS. Nakshbandi, M. M.; Hasted, J. B. (University Coll., London). Planet. Space Sci., 15: 1781-6(Nov. 1967).

Rate constants for $O^+ + O_2 \rightarrow O_2^+ + O$ and $O^+ + N_2 \rightarrow NO^+ + N$ were measured in the time dependent afterglow, with helium buffer, at gas temperatures 77°, 200°; 300° and 375°K. For the former the rate is 3.50×10^{-11} cm^3 sec^{-1} at 77°K and 1.69×10^{-11} cm^3 sec^{-1} at 300°K. For the latter the rate is 3.11×10^{-11} cm^3 sec^{-1} at 77°K and 3.72×10^{-11} cm^3 sec^{-1} at 300°K. (auth) (UK)

9024 TRANSFER RATES OF NEGATIVE MUONS FROM DEUTERIUM MESOATOMS TO HELIUM, NEON, ARGON, KRYPTON, XENON, AND NITROGEN ATOMS. Placci, A. (CERN, Geneva); Zavattini, E.; Bertin, A.; Vitale, A. Nuovo Cim. (10), 52A: 1274-86(Dec. 21, 1967).

The rates of the processes $\mu d + {}_zY \rightarrow \mu_zY + d$, in which the μ^- meson is transferred from a μd mesic atom to an atom ${}_zY$ of higher atomic number were measured (${}_zY$ stands here for helium nitrogen, neon, argon, krypton and xenon). The rates of the studied processes have been obtained, for each element ${}_zY$, by observing the time distribution of the electrons coming from the decay of negative muons stopped in gaseous deuterium (at a pressure of 6 abs atm) to which a known small proportion of the element ${}_zY$ had been added. The data obtained are discussed in relation to those concerning the $\mu p + {}_zY \rightarrow \mu_zY + p$ process (which were the result of a previous work) and to the existing theory. (auth)

9025 SCATTERING AND ENERGY TRANSFER IN THE COLLISION OF ATOMS AND MOLECULES WITH METAL SURFACES. Smith, Joe N. Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Res. Rev. (Office Aerosp. Res.), 6: No. 8, 1-5(Aug. 1967).

Results are given for helium scattering on pure and impure gold surfaces. Also, results are given for krypton scattering on silver as a function of beam temperature. (M.O.W.)

9026 QUANTUM THEORY OF EMISSION OF CHARGED POLARIZED FERMI PARTICLES MOVING IN CROSSED FIELDS. Bagrov, V. G.; Bordovitsyn, V. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 61-5(1967). (In Russian).

Studies were made of emission of charged Dirac particles moving at relativistic velocity in orthogonal electric and magnetic fields ($E \leq H$). General formulas obtained were used for the case of arbitrary particle spin orientation. A certain prevailing spin orientation should always take place in a transfer electron spin polarization. Moreover, a fraction of electrons with $\zeta = -1$ spin diminish with an increase of $\underline{\psi}$ and the effective polarization time $\underline{\tau}$ increases with the electric field. (R.V.J.)

9027 ISOTOPE SHIFT IN THE SECOND SPECTRUM OF BARIUM. Kelly, F. M.; Tomchuk, E. (Univ. of Manitoba, Winnipeg, Can.). Can. J. Phys., 45: 3931-4(Dec. 1967).

Measurements of isotope shifts and magnetic hyperfine structures have been made in λ 4934 Å in the second spectrum of barium. The measurements are compared with those of other authors. (auth) (CANADA)

9028 K-SHELL PHOTOELECTRIC CROSS SECTIONS OF 145-keV GAMMA-RAYS IN VARIOUS ELEMENTS. Ghumman, B. S.; Sahota, H. S.; Sood, B. S. (Punjab Univ., India). Curr. Sci. (India), 37: 11(Jan. 5, 1968).

The K-shell photoelectric cross sections of Ba, Dy, Au, Ho, Pb, Ag, Sn, and W for 145-KeV γ rays were measured. ^{141}Ce was used as the γ source, and the absolute yields of fluorescent K x radiation following the photoelectric interaction were recorded using an NaI(Tl) spectrometer. (D.C.W.)

9029 IONIZATION OF ARGON IN THE THRESHOLD REGION BY ELECTRON IMPACT. Peresse, J.; Tuffin, F.; Sinou, G. (Faculte des Sciences, Brest, France). Phys. Lett., 25A: 773-4(Nov. 20, 1967). (In French).

New ionization processes by electron impact using an electrostatic electron selector are reported. (auth)

9030 EXCITATION OF EXTREME ULTRAVIOLET RADIATION ("GAS-IONIZING RADIATION") IN OXYGEN BY ELECTRON COLLISIONS. Sroka, W. (Univ., Hamburg). Phys. Lett., 25A: 770-1(Nov. 20, 1967).

Electrons in electrical discharges dissociate in a single collision an oxygen molecule into an O atom and a highly excited O atom or O ion. The radiation of this dissociation product is able to ionize the O_2 molecule. The appearance potentials of this process and the excitation functions are measured. (auth)

9031 CHARGE TRANSFER OF 24- TO 75-MeV IODINE IONS IN A SUPERSONIC MERCURY VAPOR JET. Franzke, B.; Angert, N.; Moeller, A.; Schmelzer, Ch. (Univ., Heidelberg). Phys. Lett., 25A: 769-70(Nov. 20, 1967). (In German).

Charge distributions were measured after passage through a supersonic mercury vapor jet. Average equilibrium charges and charge transfer cross sections are given. The density effect occurs at target densities above 5×10^{15} atoms/cm^3. (auth)

9032 DYNAMICAL IMPLICATIONS OF O_4 IN QUANTUM MECHANICS. Werle, J. pp 728-32 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

The dynamic implications of the symmetry group O_4 of the nonrelativistic hydrogen atom are discussed. Two questions are investigated: a) whether the Coulomb potential is the only one which is permitted by the requirement of O_4 symmetry and what are the weakest assumptions which imply the Coulomb potential; and b) whether the Runge–Lenz vector is the only form of the generator which is compatible with O_4. (L.B.S.)

9033 ON THE EXISTENCE OF THE PROTON–ELECTRON–POSITRON BOUND STATE SYSTEM. Arifov, P. U.; Mal'yan, V. M. (Inst. of Electronics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 7, 26-8(1967). (In Russian).

Previously it was found that the proton–electron–positron (pe^-e^+) system is the analog of the negative hydrogen ion (pe^-e^-) and can be used for describing the ground state of the pe^-e^+ variation functions, symmetrized according to the coordinates of single charged particles. Evaluation of the energy above the ground state of the pe^-e^+ system ($E = -0.38843$ atomic units) indicated stability in relation to decay into positronium and a proton or a positron and a hydrogen atom in excited state. Calculations and comparisons of electron density distributions in pe^-e^+ and pe^-e^- showed that replacement of H^- by a positron induced significant deformation in the distribution of the negative charge. (R.V.J.)

9034 LATENT SYMMETRY OF HYDROGEN ATOMS. Popov, V. S. pp 702-27 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

A survey of work done on the "latent" symmetry of the hydrogen atom is presented with discussion of Keppler's problem in classical mechanics, the hydrogen atom and the Lorentz group, the Green function for the Coulomb potential, a generalization for the f-dimensional case, and invariance groups for the hydrogen atom. (JPRS)

9035 A MEASUREMENT OF THE CROSS SECTION FOR COLLISIONS OF THE SECOND KIND IN A NEON–HELIUM PLASMA. Bockhova, O. P.; Tolmachev, Yu. A.; Frish, S. E. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 270-1(Sept. 1967).
Translated from Opt. Spektrosk., 23: 500-2(Sept. 1967).

Measurements of the population of a number of levels in a He–Ne mixture were used to calculate cross sections for the transfer of excitation energy from the metastable He atom $He(1s2s^1S_0)$ to various neon levels under various conditions. The average cross section for the transfer of energy to the $3s_2$ level was found to be $(7 \pm 4) \times 10^{17}$ cm^2, which is several times smaller than the values obtained by other investigators. Possible explanations for the difference are considered. (A.G.W.)

9036 EFFECT OF VIBRATIONAL EXCITATION ON THE DISSOCIATION OF THE MOLECULAR HYDROGEN ION UNDER ELECTRON AND PROTON IMPACT. Oksyuk, Yu. D. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 197-201(Sept. 1967).
Translated from Opt. Spektrosk., 23: 366-73(Sept. 1967).

Effective cross sections for the transition $1s\sigma_g v \rightarrow 2p\sigma_u$ have been calculated for all the initial vibrational states v of the H_2^+ ion undergoing collisions with fast, structureless, charged particles. It has been shown that both in the Born approximation for the scattering amplitude and in the LCAO approximation for the electronic wave function an effective cross section for the transition is obtained, which is proportional to the square of the matrix element of the electric dipole moment. In the calculation of this matrix element, the vibrational wave functions have been taken into consideration. An estimate of the errors resulting from the use of the method of Winans and Stückelberg for the calculation of the effective cross sections is given. (auth)

9037 EFFECTIVE POTENTIAL METHOD FOR CALCULATING WAVEFUNCTIONS OF MONOVALENT ATOMS AND THEIR ISOELECTRONIC SEQUENCES. Zapol, B. P.; Kunin, P. E.; Taksar, I. M. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 191-2(Sept. 1967).
Translated from Opt. Spektrosk., 23: 353-6(Sept. 1967).

An effective potential method is proposed for calculating wave functions of atoms and ions with a single electron in the unfilled shell. With the aid of a central potential $U = -A_i/r$, $r_i \le r \le r_{i+1}$ ($r_0 = 0$, $r_{k+1} = \infty$) that has discontinuities at points r_i, the Li and Na atoms and ions of their isoelectronic sequences were calculated. The energy spectra obtained differ from those found experimentally by 0.01 to 2.0%. The relative oscillator strengths were calculated for some lines of the sodium spectrum; the results obtained agree quite satisfactorily with the experimental data. (auth)

9038 ROTATIONAL TEMPERATURE MEASUREMENTS IN ELECTRON-BEAM EXCITED NITROGEN. Ashkenas, Harry (Jet Propulsion Lab., Pasadena, Calif.). Contract NAS7-100. Phys. Fluids, 10: 2509-20(Dec. 1967).

Measurements of the rotational temperature of electron-beam excited nitrogen have been made along the axis of a free jet under various flow conditions. Temperatures calculated from the isentropic flow equations are compared with those derived from the rotational spectra. Discrepancies between the two temperature determinations led to an investigation of the rotational spectrum of nitrogen in thermodynamic equilibrium at 300 and at 78°K. Results of the "static" gas measurements are presented which indicate that existing models of the electron-beam excitation–de-excitation process may be incorrect. (auth)

9039 MECHANISM OF ION BOMBARDMENT-INDUCED RELEASE OF GAS FROM TUNGSTEN. Erents, K.; Carter, G. (Univ. of Liverpool). Vacuum, 17: 97-9(1967).

The release of entrapped inert gas ions (He, Ar, and Kr) from polycrystalline tungsten during bombardment with a second ion species was studied as a function of target temperature during bombardment. Inert gas ions were injected into the tungsten target using an ion gun, in an ultra-high vacuum system. Release spectra of 500-eV Kr^+ ions, injected at different target temperatures up to 950°K, revealed that following bombardment at room temperature there are peaks from 500 to 2400°K, but that after a bombardment at an elevated target temperature, T_p, the subsequent desorption spectrum is denuded below T_p and slightly above T_p. The trapped gas is evidently held in sites which require different activation energies for migration so that holding the target above the temperature for migration of some trapped atoms results in their disappearance from a subsequent spectrum. In a second type of experiment, at a constant dose of 1.5×10^{15} ions/cm^2, 500-eV Kr^+ ions were injected into tungsten at 850 and 1050°K. The target was then bombarded with 500-eV Ar^+ ions at various temperatures and the rate of release of the Kr as a function of time was determined with the mass spectrometer. The maximum initial rate of release per bombarding secondary ion was then determined as a function of target temperature for primary bombardments at target temperature at 850 and 1050°K. In another experiment, He^+ ions were initially injected, and secondary Kr bombardments conducted at room temperature, which preferentially removed the lower energy peaks. The form of the variation of release rate with temperature and the preferential removal of ions trapped with low activation energy suggested operation of a thermal spike process rather than target sputtering as the mechanism responsible for bombardment induced desorption. (BBB)

9040 RELAXATION OF POSITRON MOMENTUM DISTRIBUTION IN METALS. Woll, E. J. Jr.; Carbotte, J. P. (Mc-

Master Univ., Hamilton, Ontario). Phys. Rev., 164: 985-93 (Dec. 15, 1967).

The time-dependent momentum distribution is calculated for positrons, initially of high energy, in contact with a low-temperature electron gas. A Boltzmann-equation approach is used; the positrons are taken to have an effective mass different from the electron mass, as is observed experimentally, and to interact with the electrons via the screened Coulomb interaction. High-momentum components of the distribution decay very quickly; therefore, the Boltzmann equation is solved numerically only for momenta in the thermal range. The distribution function is found to decay with time toward the Maxwell–Boltzmann distribution, while depleting through annihilation. Effective distribution functions, describing the average properties of the positrons throughout the relaxation–annihilation process, are computed for various ratios of lifetime to thermalization time. A prediction is made of the minimum positron energy observable in annihilation experiments. (auth)

9041 A NOTE ON EXCITATION CROSS SECTION OF SOME OF THE STATES OF Ne II, Ar II, Kr II BY ELECTRON COLLISION. **Koozekanani, S. H. (Ohio State Univ., Columbus). IEEE (Inst. Elec. Electron Eng.) J. Qaunt. Electron., QE-3: 206(May 1967).**

Excitation cross sections were calculated in a previous report using the sudden perturbation approximation. It was assumed that the ground state, after losing an electron, was either 100% in a $^2P_{3/2}$ state or 100% in a $^2P_{1/2}$ state. However, it may be possible to determine in what J-value state the resulting ion would be left after losing an electron, if the order of coupling of the ground-state atom is changed from LS to JJ coupling before the loss of the electron by collision. A summation is presented in which the atomic ground state $\psi = |LSJM\rangle$ was first expressed in terms of its parent states and the order of coupling was changed. The summation is overall possible 1^5 core states $\overline{\psi} = |\overline{L}\overline{S}\rangle$ and all possible j and $\overline{J}$ values where $\overline{J} = \overline{L} + \overline{S}$. For noble gas atoms (J is either $1/2$ or $3/2$, L = S = J = 0, $\overline{L} = 1$, and $\overline{S} = s = 1/2$), calculations showed that the probability of production of states with total J = $3/2$ is favored 2 to 1 as compared to states with J = $1/2$. (BBB)

9042 TELESCOPIC SYSTEMS OF CYLINDRICAL LENSES. **Glikman, L. G.; Kel'man, V. M.; Yakushev, E. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Tekh. Fiz., 37: 1720-5 (Sept. 1967). (In Russian).**

The "cylindrical" electrostatic electron optical systems discussed in this paper are not symmetric about an axis, but with respect to t plane. Each of the three electrodes forming the two electrostatic lenses of the discussed system consists of portions of the two planes $y = \pm D/2$ (x, y, and z are rectangular Cartesian coordinates); one electrode consists of the $y = \pm D/2$, $z < -L/2$ half-planes, one, of the $y = \pm D/2$, $-L/2 < z < L/2$ strips, and one, of the $y = \pm D/2$, $z > L/2$ half planes. The gaps between the electrodes are assumed to be infinitesimal. Electron trajectories were calculated with a computer, and the results of these calculations are presented as curves showing different characteristics of the system as functions of the effective refractive index (the square root of the ratio of the effective potentials in the object and image spaces). Among the characteristics thus presented graphically are the potentials on the electrodes of the telescopic system, the position of the intermediate focus, the transverse magnification of the beam width, the focal lengths of the two lenses, and the effective plane of separation. The discussed telescopic systems should be useful in the design of mass spectrometers, and electrostatic prisms. (ATD)

9043 INFLUENCE OF HYDROGEN ON THE ELECTRON EMISSION FROM METALS BOMBARDED WITH 1- TO 10-keV IONS. **Dorozhkin, A. A.; Petrov, N. N. (Leningrad Polytechnic Inst.). Zh. Tekh. Fiz., 37: 1686-90(Sept. 1967). (In Russian).**

Secondary electron emission coefficients were measured for tantalum, molybdenum, nickel, copper and stainless steel foils bombarded with 1 to 10 keV H^+, H_2^+, and H_3^+ ions at room temperature and 1200°K in hydrogen atmospheres at pressures from 10^{-6} to 3×10^{-1} mm Hg in order to obtain information on the influence of ambient hydrogen on the adsorbed surface layers on metals. The ion beam entered the hydrogen atmosphere from the high vacuum region through a narrow slit and its path in the gas before striking the target was only 5 mm long. When the metals had not been previously baked out in vacuum, their room temperature secondary emission coefficients were independent of the ambient hydrogen pressure. When the metals were first thoroughly baked out in vacuum their secondary emission coefficients, which increased both with increasing mass and increasing energy of the bombarding ions, were still independent of the hydrogen pressure for sufficiently low pressures, and those of tantalum, molybdenum, and nickel at room temperature and tantalum and molybdenum at 1200°K were independent of the hydrogen pressure over the full investigated range. The room temperature secondary emission coefficients of copper and stainless steel increased with increasing hydrogen pressure, beginning at pressures of 0.01 and 0.003, respectively, and the 1200°K secondary emission coefficients of nickel, copper, and stainless steel decreased with increasing hydrogen pressure, beginning at pressures of 0.03-, 0.09-, and 0.01-mm Hg, respectively. When the high-temperature secondary emission coefficients of nickel, copper and stainless steel began to decrease with increasing hydrogen pressure, their thermoelectronic emission began to increase. The results are discussed briefly, and it is concluded the adsorbed layer on the surface of a metal can either increase or decrease the secondary electron emission, depending on the nature of the layer. (ATD)

9044 COMPARISON OF THE EXCITATION PRODUCED IN A HELIUM TARGET BY THE IMPACT OF H^+, D^+, H_2^+, AND H_3^+ IONS AT HIGH ENERGIES. **Thomas, E. W.; Bent, G. D. (Georgia Inst. of Tech., Atlanta). J. Opt. Soc. Amer., 58: 138-9 (Jan. 1968).**

The relative cross sections for exciting the 4^1S level of He by the impact of H^+, D^+, H_2^+, and H_3^+ ions on a neutral He target were compared at particle energies of about 0.1 to 1.0 MeV. Protons and deuterons exhibit approximately equal cross sections. The velocity dependence of the various cross sections is essentially the same, the H_2^+ and H_3^+ impact data being greater than those for proton impact by a constant factor. It is suggested that an explanation for the similarities of the excitation cross sections may be found in the concept of the effective charge of the incident molecular ion. This concept and the ratios of the measured cross sections were used to determine empirical values of the effective charge for the H_2^+ and H_3^+ projectiles of 1.20 and 1.25 e, respectively. (A.G.W.)

9045 PHOTON BREMSSTRAHLUNG FROM AN EXTREME-RELATIVISTIC ELECTRON GAS. **Alexanian, Moorad (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 165: 253-7(Jan. 5, 1968). (UCRL–70616).**

The photon bremsstrahlung spectrum from an extreme-relativistic electron gas is obtained. This gives for the total energy radiated per unit space-time volume $W_{ee}(\tau) = 24\, n^2 mc^3 r_0^2 \alpha\tau [\ln 2\tau - C + 5/4]$, where $\tau \equiv kT/mc^2 \gg 1$, and C is Euler's constant. The leading term is exactly twice that obtained when considering electron–ion bremsstrahlung and is seen to represent the fact that in electron–electron bremsstrahlung, as contrasted with electron–ion bremsstrahlung, both particles radiate. (auth)

9046 MECHANISM OF SCINTILLATION OF HELIUM, HELIUM–ARGON, AND HELIUM–NEON GAS MIXTURES EXCITED BY ALPHA PARTICLES. **Kubota, Shinzou (St. Paul's Univ., Tokyo); Takahashi, Tan; Doke, Tadayoshi. Phys. Rev., 165: 225-30(Jan. 5, 1968).**

An experimental investigation of the mechanism of scintillation of helium, helium–argon, and helium–neon mixtures excited by α particles has been performed. No detectable decrease in light yield was observed at pressures less than 3 atm when the applied electric field was increased in steps to $E/p \sim 1.0$ V/cm torr, where E is the electric field and p is the gas pressure. The pulse shape of helium scintillation light consists of a slow component and a spike appearing on the leading edge of the pulse. The main component of light intensity is represented by the formula $\exp(-t/\tau_m) - \exp(-t/\tau_f)$, where t is the time in sec, $\tau_m = 10 \times 10^{-6}$ sec, and $\tau_f = 0.3p^{-2.2\pm0.3}$ sec (p in torr). Most of the emitted photons had a wavelength of less than 1050 Å. On the basis of these results, it is concluded that the emitted photons are released in the decay of excited helium molecules formed as a result of a three-body collision between a metastable and two ground-state helium atoms. A characteristic large drop in the light yield for a mixture of a small proportion of argon in a major fraction of helium can be explained by the production of argon ions by metastable helium atoms (Penning process). The same characteristic large drop for a mixture of small concentration of neon in helium seems to be caused by the excitation transfer from helium to neon atoms. The cross section σ_f for the formation of an excited helium molecule by a three-body collision is estimated to be 50×10^{-22}p cm^2 at 300°K, where p is in torr. From the value of σ_f, the cross section σ_1 of the helium-argon Penning process is calculated as 41×10^{-16} and 14×10^{-16} cm^2 by using the ratios of σ_1 to σ_f estimated by Jesse and Sadaukis and by Northrop and Gursky, respectively. (auth)

9047 S-WAVE CROSS SECTION FOR $D(p,\gamma)^3He$. **Kolos, W. (Univ. of Chicago). Phys. Rev., 165: 165-7(Jan. 5, 1968).**

Nonadiabatic theory has been applied to calculate an accurate wave function for the $p\mu d$ muonic molecule. The value of the wave function describing the nuclear motion evaluated at an internuclear distance equal to zero yields a cross section for the $D(p,\gamma)^3He$ reaction in agreement with the experimental value. (auth)

9048 m_j MIXING IN ORIENTED $4^2P_{1/2}$ POTASSIUM ATOMS, INDUCED BY COLLISIONS WITH INERT GASES. Berdowski, W.; Krause, L. (Univ. of Windsor, Can.). Phys. Rev., 165: 158-65(Jan. 5, 1968).

A modified Zeeman scanning method was used to excite selectively the magnetic substates of the $4^2P_{1/2}$ potassium atoms mixed with inert gases and placed in a strong magnetic field. The resulting potassium—inert-gas atomic collisions induced m_j mixing in potassium, which manifested itself by the depolarization of the potassium resonance fluorescence. The polarization measurements yielded the following disorientation cross sections: K-He : 46 Å^2; K-Ne : 39 Å^2; K-A : 52 Å^2; K-Kr : 80 Å^2; K-Xe : 107 Å^2. (auth)

9049 SEQUENTIAL DECAY THEORY AND SEQUENTIAL TRANSITIONS. Mower, Lyman (Univ. of California, Berkeley). Phys. Rev., 165: 145-57(Jan. 5, 1968).

A theory of sequential decay of an unstable system is presented using the projection-operator algebra suggested by the recent projection-operator approach to reaction theory. The formulation is an attempt to provide an alternative to perturbation theory. While exact, the theory is cast in a phenomenological form that is suggestive in its interpretation and may be extended so as to apply to sequential transitions in general. Examples treated include the transition between unstable states of an atom induced by an intense electromagnetic field as well as a problem in resonance fluorescence. Higher-order corrections to the more familiar theory are a natural consequence of the description of sequential decay and sequential transitions presented here. (auth)

9050 POLARIZATION CORRECTIONS FOR SHIELDING AND ANTISHIELDING CONFIGURATIONS OF THE COPPER ATOM. Budick, B.; Levin, L. A. (Hebrew Univ., Jerusalem). Phys. Rev., 165: 141-4(Jan. 5, 1968).

The level-crossing technique has been used to measure the hyperfine structure constants of the ^{63}Cu nucleus in the $(3d)^{10}4p\ ^2P_{1/2}$ state. To exact a value for the nuclear quadrupole moment, configuration interaction effects are allowed for by performing a least-squares fit to the energy levels. The value obtained is in serious disagreement with a value for Q inferred from the $(3d)^9 (4s)^2$ configuration. The copper moment may therefore serve as a test for Sternheimer or other polarization corrections that must be invoked to explain the discrepancy. (auth)

9051 VARIATIONAL CALCULATION ON MUONIC MOLECULES. Carter, Benjamin P. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 165: 139-41(Jan. 5, 1968). (UCRL-70569).

Hylleraas-type trial functions with up to N = 120 terms are used in a variational calculation of several bound S states of muonic molecules. The convergence of the energy levels with increasing N is investigated. (auth)

9052 PHOTOIONIZATION IN THE SOFT X-RAY RANGE: Z DEPENDENCE IN A CENTRAL-POTENTIAL MODEL. Manson, Steven Trent; Cooper, John W. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 165: 126-38(Jan. 5, 1968).

Using a one-electron model with a Herman-Skillman central potential, photo-ionization calculations have been performed which emphasize the soft x-ray spectral range (~100 eV to ~2 keV). The $M_{II, III}$ (3p) subshell was studied in Ar, Cu, and Ge, as well as the $M_{IV, V}$(3d) and $M_{II, III}$ in Kr, Rh, Xe, Eu, Au, and Fm in an effort to explain the combined Z and energy dependence of the photoionization cross sections for these subshells. In addition, calculations have been performed for 3s, 4s, 5s, 4p, 5p, 4d, 5d, and 4f subshells in certain elements. The results, which are considerably different from the predictions of the hydrogenlike model, show certain regularities which are explained in terms of the potentials. Comparisons with experiment show that the model correctly predicts the gross spectral shape of photo-ionization cross sections, but the results are somewhat inaccurate in the vicinity of large absorption peaks. This calculation is considered to be a first approximation which can be improved by taking exchange into account more exactly and by including electron-electron correlation. (auth)

9053 LIMITED-BASIS-SET ANALYTIC SELF-CONSISTENT-FIELD WAVE FUNCTIONS FOR TRANSITION-METAL ATOMS. Karo, A. M. (Univ. of California, Livermore); McMurphy, F.; Nesbet, R. K. Contract W-7405-eng-48. Phys. Rev., 165: 123-6(Jan. 5, 1968). (UCRL-70476).

Self-consistent-field wave functions for the transition-metal atoms in their neutral ground-state configurations have been obtained that are close approximations to conventional, restricted Hartree—Fock functions. The atomic orbitals have been expanded in terms of linear combinations of orbitals from a basis set of 11 exponential Slater-type functions. Both the linear expansion coefficients and nonlinear exponential parameters have been optimized by means of standard variational procedures. The results show that from 80 to 90% of the energy improvement between simple Slater orbitals with nonoptimized screening parameters and the true Hartree—Fock results is obtained by using this limited, optimized basis. (auth)

9054 SCATTERING OF ELECTRONS BY ATOMIC SYSTEMS. Smith, Kenneth; Morgan, Lesley A. (Univ. of Nebraska, Lincoln). Phys. Rev., 165: 110-22(Jan. 5, 1968).

The theory of the scattering of electrons by atoms or ions with any number of incomplete subshells is developed within the Hartree—Fock, or close-coupling, approximation. Allowance is made for the target system to be excited to any electronic configuration constructed from discrete orbitals. The one-electron orbitals of the discrete subshells are assumed known; the scattering (continuum) functions are given as the solutions of coupled integrodifferential equations with prescribed boundary conditions. The form of these equations is such that the continuum functions are orthogonal to all the discrete orbitals. The potential terms appearing in the equations are written in terms of the generalized angular momentum recoupling coefficients. A technique for calculating these coefficients on a computer, which is a complicated algebraic problem, is presented in an Appendix. A computer code for calculating the various elastic, inelastic, and photoionization cross sections has been written and is currently being tested. (auth)

9055 THEORY OF NUCLEAR HYPERFINE INTERACTIONS IN SPHERICAL-TOP MOLECULES. Yi, Pon-nyong (Harvard Univ., Cambridge, Mass.); Ozier, Irving; Anderson, C. H. Phys. Rev., 165: 92-109(Jan. 5, 1968).

The problem of nuclear hyperfine interactions in spherical-top molecules is treated by the methods of group theory. The tetrahedral molecules CH_4 and CD_4 are considered as specific examples. For these systems in their ground electronic and vibrational states, the complete effective rotational and hyperfine Hamiltonian W is discussed and put into a form which is manifestly irreducible and invariant under the operations of the full three-dimensional rotation-reflection group R(3) and the molecular point group T_d. The spin-rotation, direct spin-spin, electron-coupled spin-spin, nuclear quadrupole, and shielding interactions are treated in detail, along with the centrifugal-distortion Hamiltonian W_{dist}. The physical mechanism giving rise to each of these terms is discussed briefly. A representation Γ is found which is suitable for the calculation of the eigenvalues of the total Hamiltonian. The total wave functions required for carrying out this calculation to first order in high-field perturbation theory are derived for arbitrary rotational momentum J. In particular, both the spin functions and the rotational functions which transform by the T_1 and T_2 representations of the tetrahedral point group T_d are developed. The rotational functions are constructed so as to diagonalize W_{dist} exactly. Their explicit form depends on coefficients which have been calculated numerically. The methods used in generating the total wave functions are sufficiently general that they can be easily extended to more complex spherical molecules. In terms of the theory presented here, it will subsequently be possible to analyze a series of molecular-beam magnetic-resonance experiments which has been recently completed. Moreover, the treatment of nuclear spin relaxation for these molecules should be considerably simplified. (auth)

9056 PRECISION MEASUREMENT OF THE ELECTRONIC g FACTORS OF THE ALKALI METALS. Vanden Bout, Paul A.; Aygun, Erol; Ehlers, Vernon J.; Incesu, Tuncay; Saplakoglu, Adnan; Shugart, Howard A. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 165: 88-91(Jan. 5, 1968). (UCRL-17668).

The ratios of the electronic g factors of ^{23}Na, ^{85,87}Rb, and ^{133}Cs to that of ^{39}K were measured using the atomic-beam magnetic-resonance technique. The results are $g_J(^{23}Na)/g_J(^{39}K) = 1.0000007$ (2), $g_J(^{85,87}Rb)/g_J(^{39}K) = 1.0000182$ (2), and $g_J(^{133}Cs)/g_J(^{39}K) = 1.0001231$ (3). These results, combined with the results of other researchers, yield the following absolute g factors for the alkali metals: $g_J(Na) = -2.002297$ (2), $g_J(K) = -2.002295$ (2), $g_J(Rb) = -2.002332$ (2), and $g_J(Cs) = -2.002542$ (2). These g factors, with the exception of the value for Cs, are in good agreement with theoretical values. (auth)

9057 ALIGNMENT OF THE H_2^+ MOLECULAR ION BY SELECTIVE PHOTODISSOCIATION. II. EXPERIMENTS ON THE RADIO-FREQUENCY SPECTRUM. Richardson, C. B.; Jefferts, K. B.; Dehmelt, H. G. (Univ. of Washington, Seattle). Phys. Rev., 165: 80-7(Jan. 5, 1968).

Magnetic resonance transitions have been observed among Zeeman sublevels of the hyperfine states of H_2^+ in magnetic fields from 50 to 115 mG. The following g-factor ratios $g(KF_2F)/g(K'F_2'F')$ were determined: $g(1\ \tfrac{1}{2}\ \tfrac{3}{2})/g(1\ \tfrac{3}{2}\ \tfrac{5}{2}) = 0.584(3)$; $g(1\ \tfrac{3}{2}\ \tfrac{3}{2})/g(1\ \tfrac{3}{2}\ \tfrac{5}{2}) = 1.241(6)$; $g(1\ \tfrac{1}{2}\ \tfrac{3}{2})/g(3\ \tfrac{3}{2}\ \tfrac{9}{2}) = 1.051(5)$. An analysis using the ratios yields equations relating the hyperfine interaction constants b, c, and d in the Hamiltonian $H = bI\cdot S + cI_zS_z + dK\cdot S$, such as $(\sqrt{2}c/6-\sqrt{2}d/3)/(3b/2+23c/30-d/6) = (8/\sqrt{5})\{[g(1\ \tfrac{1}{2}\ \tfrac{3}{2})/g(3\ \tfrac{3}{2}\ \tfrac{9}{2})]-1\}$. When nuclear contributions to the g factors are included and a weighted average of the measured ratios is used with theoretical values of b and c from the literature, a value for d may be obtained. The result is d = 32.2 ± 5.1 MHz. With this it is possible to predict the H_2^+ hfs spectrum in the 20-cm region with an error estimate of a few MHz. $(1\ \tfrac{3}{2}\ \tfrac{3}{2}) - (1\ \tfrac{1}{2}\ \tfrac{3}{2}) = 1415.3$ MHz; $(1\ \tfrac{3}{2}\ \tfrac{3}{2}) - (1\ \tfrac{1}{2}\ \tfrac{1}{2}) = 1400.9$ MHz; $(1\ \tfrac{3}{2}\ \tfrac{5}{2}) - (1\ \tfrac{1}{2}\ \tfrac{3}{2}) = 1398.1$ MHz; $(1\ \tfrac{3}{2}\ \tfrac{1}{2}) - (1\ \tfrac{1}{2}\ \tfrac{3}{2}) = 1322.4$ MHz; $(1\ \tfrac{3}{2}\ \tfrac{1}{2}) - (1\ \tfrac{1}{2}\ \tfrac{1}{2}) = 1308.2$ MHz. The ion sample is contained electrically in an rf quadrupole trap where production and analysis of alignment is by selective optical excitation by linearly polarized light of the transition $1s\sigma-2p\sigma$ leading to dissociation. The mechanism is briefly reviewed. A description is given of the trap and apparatus for the detection of the trapped ions and magnetic resonance. (auth)

9058 CLASSICAL APPROXIMATION FOR IONIZATION BY PROTON IMPACT. Garcia, J. D. (Univ. of Pittsburgh); Gerjuoy, E.; Welker, Jean E. Phys. Rev., 165: 66-72(Jan. 5, 1968).

Ionization of atoms by proton impact, as predicted by the classical binary-encounter approximation, is examined and compared with available experimental data on the noble-gas and alkali-metal atoms. The results indicate that these predictions agree with observation to within a factor of 2 or 3, and are as reliable as the comparable results for electron ionization. Comparisons are made between electron and proton ionization cross sections. The proton ionization curves all have a single maximum and are otherwise monotonic, in contrast to electron ionization, where the effects of atomic shell structure produce secondary maxima for some atoms. The effect of averaging over bound-state speed distributions is discussed, and is found to be much less important for protons than for electrons, except at very low proton energies. The need for experimental measurements at higher energies (~10 MeV) is discussed. (auth)

9059 CLASSICAL CALCULATIONS OF CHARGE-TRANSFER CROSS SECTIONS. Garcia, J. D. (Univ. of Pittsburgh); Gerjuoy, E.; Welker, Jean E. Phys. Rev., 165: 72-80(Jan. 5, 1968).

The utility of Gryzinski's classical procedure for estimating charge-transfer cross sections is examined. The essential content of the method is that charge transfer occurs whenever the energy transferred in a Coulomb collision between the incident ion and the transferring electron lies between specified limits. For protons incident on noble-gas and alkali atoms, it is found that the procedure in its present form is not as reliable for predicting charge-transfer cross sections as for ionization, though individual examples of remarkable agreement are found. Nevertheless, it remains possible that a more sophisticated classical approach can reasonably account for charge transfer. (auth)

9060 DOMINANT NONADIABATIC CONTRIBUTION TO THE LONG-RANGE ELECTRON–ATOM INTERACTION. Kleinman, Chemia J.; Hans, Yukap; Spruch, Larry (New York Univ., N. Y.). Phys. Rev., 165: 53-62(Jan. 5, 1968).

In the scattering of low-energy electrons or positrons by spherically symmetric atoms, a significant role is played by the long-range interactions. These originate partially in the adiabatic polarization of the atom, which contributes $1/q^4$, $1/q^6$, and higher terms, where q is the electron–atom separation. There is also a nonadiabatic contribution, which behaves asymptotically as $3\alpha_d\beta_1(e')^2/q^6$, where e′ is the charge of the incident particle; this contribution was first studied by Mittleman and Watson in the case of hydrogen. We have obtained a useful if formally trivial extension of their results on β_1 to a wide class of atoms. We have also obtained rigorous if sometimes crude upper and lower bounds on β_1 which depend upon the availability of some information on the low-lying atomic energy levels and the associated oscillator strengths, and on the electric dipole polarizability. Bounds on β_1 have been obtained for He, Li, Ne, and Na. Statistical moment studies lead to estimates of β_1 for the rare-gas atoms. (auth)

9061 RELATIVE CHARGE-TRANSFER EFFICIENCIES OF $^2P_{1/2}$ AND $^2P_{3/2}$ XENON IONS IN Xe AND IN O_2. Amme, Robert C.; Haugsjaa, Paul O. (Univ. of Denver). Phys. Rev., 165: 63-5 (Jan. 5, 1968).

We have shown that the concentration of Xe^+ $^2P_{1/2}$ ions formed in an electron-impact ion source may be monitored by utilizing near-resonant charge transfer of Xe^+ beams with molecular oxygen. This measurement provides a means of assaying the fraction of excited ions in the Xe^+ beam and affords a technique for studying the effects of fine structure on the symmetric charge-transfer process: $Xe^+ + Xe \rightarrow Xe + Xe^+$. With 25-eV electrons, we find that the Xe^+ beam is about 80% $^2P_{3/2}$ state, while the remaining 20% appears to be principally $^2P_{1/2}$. The charge-transfer cross section for the excited component in xenon was found to be 1.0 ± 0.15 relative to that of the $^2P_{3/2}$ ion, over a large range of incident ion energy. (auth)

9062 TESTS OF BORN APPROXIMATIONS: DIFFERENTIAL AND TOTAL 2^3S, 2^1P, AND 2^1S CROSS SECTIONS FOR EXCITATION OF He BY 100- TO 400-eV ELECTRONS. Vriens, L.; Simpson, J. Arol; Mielczarek, S. R. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 165: 7-15(Jan. 5, 1968).

The angular dependence of 2^3S, 2^1P, and 2^1S excitation of He for incident electron energies from 100 to 225 eV (2^3S) and 400 eV (2^1P and 2^1S) has been measured. Apparent generalized oscillator strengths f(K) and differential cross sections for the transition $1^1S \rightarrow 2^1P$ are obtained by normalizing to Schiff and Pekeris's optical oscillator strength. From the experimental intensity ratios $2^3S/2^1P$ and $2^1S/2^1P$ we then calculate differential $1^1S \rightarrow 2^3S$ and $1^1S \rightarrow 2^1S$ cross sections. The differential cross sections are integrated to get total cross sections. The f(K) found here for 2^1P and 2^1S excitation decrease faster with increasing momentum transfer $K\hbar$ than in earlier studies. Departures from the Born approximation appear only below 200 eV for 2^1P excitation, but occur at higher energy and are larger (especially for large momentum transfers) for 2^1S excitation. The angular dependence found for 2^3S excitation disagrees strongly with the Ochkur (Bonham) approximation. Our total 2^3S cross sections are much lower than all other existing theoretical and experimental data. (auth)

9063 EMISSIONS FROM A MOLECULAR HYDROGEN TARGET INDUCED BY THE IMPACT OF FAST PROTONS. Edwards, J. L.; Thomas, E. W. (Georgia Inst. of Tech., Atlanta). Contract AT(40-1)-2591. Phys. Rev., 165: 16-17 (Jan. 5, 1968). (ORO-2591-31).

Cross sections have been measured for the emission of bands of the molecular hydrogen spectrum induced by the impact of protons on a molecular hydrogen target under single-collision conditions. Comparisons are made with the general predictions of the Bethe–Born theory. Cross sections for the emission of Balmer radiation produced by simultaneous dissociation and excitation of the target are also presented. (auth)

9064 CROSS SECTIONS FOR THE FORMATION OF EXCITED STATES IN A NITROGEN TARGET BY THE IMPACT OF 0.15- TO 1.0-MeV PROTONS. Thomas, E. W.; Bent, G. D.; Edwards, J. L. (Georgia Inst. of Tech., Atlanta). Contract AT(40-1)-2591. Phys. Rev., 165: 32-9(Jan. 5, 1968). (ORO-2591-30).

Protons in the energy range 0.15 to 1.0 MeV were incident on a molecular nitrogen target and the resulting emission was analyzed spectroscopically. Absolute measurements were made of the intensity of certain spectral lines. Cross sections are presented for the emission of two prominent lines of singly ionized atoms and for nine lines from the N_2^+ first positive band system. Cross sections for the population of the v′ = 0 and v′ = 1 vibrational levels of the B $^2\Sigma$ excited state of N_2^+ are obtained from the emission functions. In the present work, the proportion of N_2^+ ions formed in the excited state remains almost independent of impact energy, indicating that the excited N_2^+ ions are produced by simultaneous ionization and excitation of the target. The measured relative populations of two vibrational levels in the N_2^+ ion are shown to be in good agreement with the ratios of the relevant overlap integrals. An investigation of the emission of the N_2 second positive system shows that it is mainly excited by secondary-electron impact, the cross section for proton impact excitation of the C $^3\Pi$ state of the N_2 molecule being some three orders of magnitude less than that for electrons at the same impact velocity. This indicates the importance of spin conservation in governing the transitions which occur in collisional excitations by heavy-particle impact. (auth)

9065 ATOMIC FORM FACTOR AND INCOHERENT-SCATTERING FUNCTION OF THE HELIUM ATOM. Kim, Yong-ki; Inokuti, Mitio (Argonne National Lab., Ill.). Phys. Rev., 165: 39-43(Jan. 5, 1968).

The atomic form factor and the incoherent-scattering function of the helium atom have been calculated from several wave functions of differing accuracies. The form factor calculated from the Hartree–Fock wave function is in very close agreement with that from the 20-term Hylleraas wave function for all values of the momentum transfer. For small mementum transfers (<3 atomic units), the incoherent-scattering function is sensitive to the wave function used, but it becomes insensitive for large momentum transfers. Correlated wave functions give values of the incoherent-scattering function, at small momentum transfers, approximately 5% lower than the Hartree–Fock wave function does. Consequences of the above results in the calculation of x-ray and electron-scattering cross sections are discussed. (auth)

9066 ON THE CORE POLARIZATION OF THE Rb ATOM: HYPERFINE STRUCTURE OF THE 7 $^2P_{1/2}$ STATE OF ^{85}Rb. Feiertag, D.; zu Putlitz, G. (Univ., Heidelberg). Z. Phys., 208: 447-58(1968). (In German).

The hyperfine structure splitting of the 7 $^2P_{1/2}$ state of ^{85}Rb has been investigated with optical double resonance spectroscopy. The results are: $\nu_{F=3-F=2}$ = 52.95(6) Mc/s; $A_{J=1/2}$ = 17.65(2) Mc/s; g ($7^2P_{1/2}$, Rb) = 0.6668(1). From the hfs interaction constants of the 7 ^{2}P multiplet a 12% core polarization contribution to the magnetic hfs of the 7 $^2P_{1/2}$ state can be deduced. Comparison is made between the values of $\langle r^{-3}\rangle$ calculated from either the magnetic hfs or the ^{2}P fine structure separation. (auth)

9067 BREMSSTRAHLUNG SPECTRUM OF A FAST ELECTRON IN A SINGLE CRYSTAL. Kalashnikov, N. P.; Ryazanov, M. I. (Inst. of Engineering Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 110-11(Aug. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 609-10(Aug. 15, 1967).

A brief theoretical analysis of the bremsstrahlung process is given. (M.O.W.)

9068 LIFETIME MEASUREMENT OF THE $3d^94s$ 4p $^4P_{5/2}$ STATE OF Cu WITH OPTICAL DOUBLE RESONANCE. Kowalski, J.; zu Putlitz, G. (Univ., Heidelberg). Z. Phys., 208: 459-63(1968). (In German).

The lifetime of the $3d^9$ 4s 4p $^4P_{5/2}$ state of Cu has been determined with optical double resonance by observation of radiofrequency transitions $\Delta F = 0$, $\Delta m_F = \pm 1$ between hfs-Zeeman levels of the stable odd isotopes. The result is $\tau(3d^9\ 4s\ 4p\ ^4P_{5/2}, \mathrm{Cu})$ = 3.18 (16) × 10^{-7} sec. (auth)

9069 EMISSION FROM ORGANIC LIQUIDS EXCITED BY ELECTRON IMPACT. Carter, J. G.; Christophorou, L. G., Abu-Zeid, M.-E. M. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 47: 3879-84(Nov. 15, 1967). (ORNL-P-3162).

Liquid benzene, toluene, and 2-ethyl naphthalene were excited at room temperature with intense electron beams (average energies, 4 to 36 keV) and in all cases the scintillation emission was a structureless band attributed to excimers. A comparison is made of the emission spectra obtained this way with the photofluorescence spectra and those obtained under x-ray excitation. Ion recombination is believed to be the origin of the excimeric emission under electron bombardment. The conclusion is drawn that the emission from organic liquids is strongly dependent upon the mode and intensity of excitation. (auth)

9070 EVALUATION OF CO_2^+ $^2\Pi_u \rightarrow {}^2\Pi_g$ VIBRATIONAL TRANSITION PROBABILITIES. Poulizac, M. C.; Dufay, M. (Faculte des Sciences, Lyon). Astrophys. Lett., 1: 17-20(Sept. 1967).

The spectrum of carbon dioxide excited by proton impact was studied in the region 2700 to 11000 Å. The energy of incident particles varied from 30 to 600 keV for target gas pressures in the range 5 × 10^{-4} to 5 × 10^{-2} torr. The intensities of the $^2\Pi_u \rightarrow {}^2\Pi_g$ CO_2^+ system were measured and the vibrational transition probabilities of these bands approximately deduced from them. (auth)

9071 THEORY OF ONE-COMPONENT FLUX OF PARTICLES OF LIKE CHARGE. Ogorodnikov, S. N. Radiotekh. Elektron., 12: 1616-23(Sept. 1967). (In Russian).

The one-component flux of particles of like charge was studied, considering the space charge and using the theory of a system of total differential equations. Satisfactory conditions were found for a one-component flow. An expression was developed for the electrostatic potential inside the beam. The method was applied in the case of three-dimensional flow. (tr-auth)

9072 INCOHERENT SCATTERING OF GAMMA RAYS IN Ag, Pt, AND Bi. Parthasaradhi, K. (Andhra Univ., Waltair, India). Nuovo Cim. (10), 52B: 555-6(Dec. 11, 1967).

With the availability of accurate theoretical cross sections and extensive data utilizing the Thomas–Fermi model on coherent and incoherent scattering of gamma rays, it is of real interest to study the effect of electron binding on the incoherent scattering of gamma rays, especially in heavy elements. With this in view the present investigations were taken up in Ag, Pt, and Bi and the results along with a discussion in the light of the theoretical estimates based on the Thomas–Fermi model are reported. (W.D.M.)

9073 POSITRON BOUND STATES IN ALKALI HALIDES. Bussolati, C.; Dupasquier, A.; Zappa, L. (Istituto di Fisica del Politecnico, Milan). Nuovo Cim. (10), 52B: 529-38(Dec. 11, 1967).

The time annihilation spectrum of positrons in alkali halides was investigated by means of high-resolution timing technique. The decay was found to be complex in agreement with previous results. The spectra were consistently resolved in two components and in some cases in three components. The analysis of the whole set of the measured lifetimes and intensities has allowed an insight into some peculiarities of the decay; a discussion is given on the basis of a model in which the positron is considered as being bound to a negative ion. By assigning the main components, τ_1 and τ_2, to the annihilation from the ground and first excited levels, the system (anion-e^+) was found to have a size (a few 10^{-8}cm) that makes plausible its existence inside the crystals. (auth)

9074 SOME QUESTIONS OF THE RADIO-OPTICAL RESONANCE IN ^{3}He. Skrotzkii, G. V.; Pokazanev, V. G.; Yakub, L. I. (Physical Technical Inst., Moscow). Nuovo Cim. (10), 52B: 469-75(Dec. 11, 1967).

The Zeeman splitting and optical orientation of the 2 $^3S_1$ state of ^{3}He in the absence of the radio-frequency field are considered. The expressions for determination of Zeeman transition frequencies in arbitrary magnetic fields are derived. It is shown that under the optical pumping one of the sublevels can acquire a predominating population. The transitions in the 2 $^3S_1$ state caused by the rf field of the resonance frequency are considered. It is shown, that the coherence which arises in the system at the same time is caused both by one- and two-quantum transitions. The latter is found in the fact, that the transverse ray of light is modulated by the frequencies ω_0 and $2\omega_0$. (auth)

9075 COULOMB WAVE APPROXIMATION APPLIED TO THE ELECTRON IMPACT EXCITATION AND IONIZATION OF ATOMS. Kang, I.-S. (Univ. of Massachusetts, Amherst); Foland, W. D. Proc. Phys. Soc. (London), 92: 263-5(Sept. 1967).

A Coulomb wave perturbation theory is formulated to study the excitation and the ionization of atoms by electron impact. Some features of the theory and its immediate consequences, including threshold laws, are discussed. (auth) (UK)

9076 CALCULATION OF FIRST- AND SECOND-ORDER FEYNMAN DIAGRAMS FOR THE LOWER EXCITATION LEVELS OF He. Safronova, U. I.; Ivanova, A. N.; Ivanov, L. N.; Tolmachev, V. V. (Inst. of Physics and Chemistry, Moscow. Inst. of Physical Chemistry, Moscow. Moscow State Univ.). Teor. Eksp. Khim., 3: 571-8(Sept.-Oct. 1967). (In Russian).

A perturbation field theory was used for the two-electron atomic system. The lower levels of excitation (configurations 1s2s and 1s2p) were studied and the contributions from the first- and second-order diagrams are calculated. (tr-auth)

9077 DIFFERENTIAL AND TOTAL CROSS SECTION FOR THE EXCITATION OF THE 15-eV-PLASMON LOSS IN Al BY ELECTRONS. Wienhold, P. (Univ., Hamburg). Z. Phys., 208: 313-21(1968). (In German).

Energy spectra of 50-keV electrons scattered inelastically in thin Al foils of various thicknesses were measured as a function of scattering angle. The measured angular distribution of electrons which have excited one or more volume plasmons is compared with theoretical calculations and good agreement is obtained. From the integrated intensities, the mean free path of 50-keV electrons for plasmon excitation is determined with an accuracy of about 20%. The resulting value Λ = 820 Å is in good agreement with the theoretical value calculated from Ferrell's free electron model (Λ = 760 Å). (auth)

9078 SMALL-ANGLE SCATTERING OF X RAYS BY HOMOGENEOUS LIQUIDS. Thomas, Peter (Technische Hochschule, Munich). Z. Phys., 208: 338-51(1968). (In German).

Small angle scattering of Cu–K_α X rays by ethyl ether as well as water was measured at room temperature and atmospheric pressure. A totally reflecting optical flat was curved cylindrically. It was used for the production of a partially monochromatic beam converging in the vertical direction. The incident intensity was measured absolutely with a rotating slit system and a strongly scattering auxiliary probe. The resulting interference functions S were found to be independent of the scattering angle. They correspond well with the theoretical value at zero scattering angle. The theoretical value is proportional to the isothermal compressibility and the density of the scattering particles. (auth)

9079 INTERFERENCES IN ATOMIC COLLISION PROCESSES AND THEIR INTERPRETATION USING A MODIFIED LENNARD–JONES POTENTIAL. Buck, U.; Pauly, H. (Univ., Bonn). Z. Phys., 208: 390-417(1968). (In German).

The influence of the shape of the interatomic potential on the total and differential scattering cross section, with special consideration given to interference effects, was numerically studied with the help of a 5-parameter modified Lennard-Jones potential. It is shown that the experimental data for the systems Na–Kr and Na–Xe, for which precise measurements are available, can be well reproduced with the use of such a potential. The absolute value and velocity dependence of the total scattering cross section, as well as rainbow scattering and rapid oscillations in the differential scattering cross section, were all used in the comparison of the calculated with the experimental values. In addition, the modified potential was used in a re-evaluation of recent experimental results for alkali metal–inert gas scattering. (auth)

9080 THE g FACTOR OF THE ELECTRON. Crane, H. R. Sci. Amer., 218: 72-4; 79-85(Jan. 1968).

The history of the work on the g factor of the electron at the University of Michigan is given. The experimental apparatus is described and the results are explained. (M.H.R.)

9081 LINEAR POLARIZATION OF THIN-TARGET-BREMSSTRAHLUNG. Scheer, M.; Trott, E.; Zahs, G. (Univ., Wuerzburg, Ger.). Z. Phys., 209: 68-76(1968). (In German).

For electron energies of 50 and 180 keV the linear polarization in the bremsstrahlung spectrum was investigated. In the case of lower energy, measurements were taken for the angular dependence of the polarization with a low-Z target (Z = 6). At the higher energy results are given for two targets (Al_2O_3 and Au) at a fixed emission angle (angle of maximum polarization = 48°). The measurements are compared with theoretical calculations and with the experimental results of Motz and Placious. (auth)

9082 VARIATIONAL CALCULATION OF EXPECTED VALUES FOR THE HELIUM ATOM. Delves, L. M. (Univ. of Sussex, Brighton, Eng.). Proc. Phys. Soc. (London), 92: 55-61 (Sept. 1967).

A variation principle for the expected values of Hermitian operators was previously derived. The present paper describes a calculation on the ground state of the helium atom, which uses this principle to obtain variational estimates of the expected values of a number of operators. Trial functions containing up to fifty parameters are used, and the results justify a cautious optimism over the practicability of the approach. (auth) (UK)

9083 VARIATIONAL METHODS OF THE HULTHEN-KOHN TYPE. John, T. L. (University Coll., Cardiff, Wales). Proc. Phys. Soc. (London), 92: 62-6(Sept. 1967).

It is shown that the variational methods of Hulthén, Kohn and Malik are members of a larger group of methods which can be applied in scattering theory. These methods are illustrated, compared, and applied to the elastic scattering of electrons by hydrogen atoms. (auth) (UK)

9084 INFLUENCE OF ELECTRON DISTRIBUTION ON ATOMIC INTERACTION POTENTIALS. Wedepohl, P. T. (Univ. of Witwatersrand, Johannesburg). Proc. Phys. Soc. (London), 92: 79-93(Sept. 1967).

The interaction energy between pairs of like atoms and ions was calculated for different distributions of the atomic electrons. In the energy range which is of interest for radiation damage calculations the interaction energies calculated in the case of neutral argon for Hartree electron densities are up to 30% higher than those calculated for Thomas–Fermi–Dirac densities. For Cu^+, Al^+ and neutral neon the difference is 15% or less. The difference between the argon–argon interaction energies calculated by Firsov from the Thomas–Fermi model, and those calculated by Abrahamson from the Thomas–Fermi–Dirac model, is larger than might be expected from the approximations involved. The results of the present paper are in good agreement with those of Firsov. (auth) (UK)

9085 MOBILITY OF DOUBLY CHARGED IONS IN THEIR PARENT GASES. Janev, R. K.; Pesic, S. S. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Proc. Phys. Soc. (London), 92: 94-9(Sept. 1967).

Starting from the exact asymptotic expression of the energy separation of the symmetrical and antisymmetrical states of the system A_2^{2+} (where A is an inert gas atom), the effective cross sections for momentum transfer in A^{2+} + A collisions, as well as the mobilities of A^{2+} ions in their own gases, are calculated over a wide range of temperatures (100 to 20,000°K). The results are compared with classical predictions at low temperatures and previous calculations for helium. At T = 300°K the following values for the reduced mobilities of He^{2+}, Ne^{2+}, Ar^{2+}, Kr^{2+} and Xe^{2+} are obtained: 25.2, 7.98, 2.75, 1.55 and 1.01 $cm^2\ v^{-1}\ sec^{-1}$, respectively. (auth) (UK)

9086 ABSORPTION AND EMISSION OF CONTINUOUS RADIATION BY LITHIUM IONIZED GAS. Ya'akobi, B. (Hebrew Univ. of Jerusalem). Proc. Phys. Soc. (London), 92: 100-6 (Sept. 1967).

Cross sections for the absorption of radiation by the lithium atom due to photoionization and inverse bremsstrahlung are calculated and depicted as a function of wavelength in the range 1800 to 9000 Å. The corresponding absorption and emission coefficients are deduced for wavelengths in this range and temperatures in the range 2500 to 150,000°K. A comparison is made with the measured continuum emitted by exploded lithium wire for low capacitor energies; the continuum in the visible and near ultraviolet regions is shown to be predominantly due to radiative recombination. (auth) (UK)

9087 THERMAL CONDUCTIVITY OF H_2–He AND D_2–He SYSTEMS. Tondon, P. K.; Gandhi, J. M.; Saxena, S. C. (Univ. of Rajasthan, Jaipur, India). Proc. Phys. Soc. (London), 92: 253-5(Sept. 1967).

Interest has arisen in the thermal conductivity of the H_2–He gas system because of some views suggesting an abnormal composition dependence. Some theoretical and experimental studies are described, and it is concluded that the system has a normal composition variation. (auth) (UK)

9088 ELECTRON CAPTURE BY FAST PROTONS IN HELIUM. Sin Fai Lam, L. T. (Univ. of Durham, Eng.). Proc. Phys. Soc. (London), 92: 67-74(Sept. 1967).

The impact parameter formalism is used to calculate the cross sections for the electron capture reaction $H^+ + He(1s^2) \rightarrow H(1s, 2s, 2p) + He^+(1s)$ over the energy range 1 to 1000 keV. It is concluded that the inclusion of the excited states of hydrogen does not improve the agreement of the theory with experiment for capture summed over all final states. The calculated cross sections for capture into the 2s and 2p states agree reasonably well with the few measurements available. (auth) (UK)

9089 SADDLE-POINT CHARACTER OF THE HARTREE–FOCK ENERGY. Hibbert, A.; Coulson, C. A. (Oxford Univ.). Proc. Phys. Soc. (London), 92: 17-22(Sept. 1967).

A discussion is given of the best way to improve a wave function, for the ground state of a two-electron atom, when starting with either a full Hartree–Fock wave function or some analytic approximation to it (as in the Hylleraas–Eckart function for helium). In both cases the Hartree–Fock energy is a saddle point, and it is possible to give formulae from which the direction of steepest descent towards the best open-shell function may be determined. Numerical calculations are made for the case of helium. (auth) (UK)

9090 ANGULAR CORRELATION OF POSITRON ANNIHILATION RADIATION FROM SOLID AND LIQUID BISMUTH AND MERCURY AND A BISMUTH–MERCURY ALLOY. West, R. N. (Univ. of East Anglia, Norwich, Eng.); Borland, R. E.; Cooper, J. R. A.; Cusack, N. E. Proc. Phys. Soc. (London), 92: 195-205(Sept. 1967).

Experiments are reported which measured the angular correlation of gamma rays from positron annihilation in solid and liquid mercury, solid and liquid bismuth, and a liquid bismuth–mercury alloy. The positron wave functions, and the angular correlations to be expected from positrons annihilating in the ion cores, are calculated in the single-electron approximation. It is not possible to use these calculations to subtract core annihilation from the total observed annihilation because the shapes of the theoretical and experimental curves do not agree at large angles. This situation is discussed. Valence electron annihilation is shown to be more probable relative to core annihilation, in the liquids than in the solids, and for liquid bismuth it is compared with theoretical calculations by Ballentine. (auth) (UK)

9091 DIPOLE POLARIZABILITIES OF THE SODIUM SEQUENCE. Cohen, M.; Drake, G. W. F. (York Univ., Toronto). Proc. Phys. Soc. (London), 92: 23-36(Sept. 1967).

The dipole polarizabilities and shielding factors of all members of the sodium isoelectronic sequence are calculated as functions of the nuclear charge Z using an extension of a theory recently developed by Cohen. The results of calculations within the framework of the Hartree–Fock approximation are compared with those of more accurate approximations, as well as with experiment. (auth)

9092 THE SINGLET S STATES OF THE HELIUM ISOELECTRONIC SEQUENCE. Cohen, M.; McEachran, R. P. (York Univ., Toronto). Proc. Phys. Soc. (London), 92: 37-41(Sept. 1967).

A matrix method is employed to calculate the energy eigenvalues and the corresponding orbital wave functions for a number of ^1S states of the helium isoelectronic sequence. The "inner" 1s-electron orbital is represented by a hydrogenic wave function, while the valence electron orbital is expanded in a complete set of Laguerre functions. Results are presented for the 1 ^1S, 2 ^1S and 3 ^1S states of He, Li^+, and Be^{2+}. (auth) (UK)

9093 ANALYTICAL WAVE FUNCTIONS FOR THE 1snp ^1P AND ^3P STATES OF THE HELIUM ISOELECTRONIC SEQUENCE. Ali, M. A. (Univ. of York, Eng.); Dasgupta, N. K. Proc. Phys. Soc. (London), 92: 50-4(Sept. 1967).

Approximate analytical Hartree–Fock wave functions were obtained for 1 snp ^1P and ^3P states of the He-like isoelectronic sequence up to N^{5+} for n = 2, 3, 4 and 5. Calculated energy eigenvalues compare well with previous results obtained by Davidson for n = 2, 3 and 4 for helium and Perrin and Stewart for n = 2. New results for higher members of the isoelectronic sequence are presented. (auth) (UK)

9094 SCATTERING OF ALKALI-METAL IONS BY HELIUM ATOMS. Forst, G. (Jetzt Fachschule fuer Optik und Fototechnik, Berlin-Charlottenburg, Ger.). Z. Naturforsch., 22a: 1628(Oct. 1967). (In German).

In order to investigate the dependence of the polarization effect on the mass of the scattered ions, 30-keV alkali metal ions were scattered on He atoms. The scattering angle was measured and the effective radius of polarization $\bar{a}$ was determined. With increasing mass of the ions the $\bar{a}$ value increases. $\bar{A}$ values calculated in the high-energy approximation show the same functional dependence and are in the same order of magnitude as the experimentally determined values. (J.S.R.)

9095 DISSOCIATIVE ELECTRON CAPTURE AND EVALUATION OF THE LEVEL WIDTHS OF QUASI-STATIONARY MOLECULAR STATES. Dubrovskii, G. V.; Ob'edkov, V. D.; Yanev, R. K. (Leningrad State Univ.). Teor. Eksp. Khim., 3: 601-5 (Sept.-Oct. 1967). (In Russian).

Cross sections of dissociative electron capture in $e + A_2 \rightarrow A + A^-$ type reactions were calculated within the limits of the theory of perturbation. Considering the conditions of quantitative theory agreement with experiments the following mean level widths were obtained for the quasi-stationary states of the first three H_2^- terms: $\Gamma_1 \simeq 1.2$ eV, $\Gamma_2 \simeq 0.2$ eV, and $\Gamma_3 \simeq 0.05$ eV. (tr-auth)

9096 HYPERFINE INTERACTIONS. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967. 772p. $16.00; 128s.

Basic principles, current status, and latest advances in the field of hyperfine interactions and associated phenomena are covered. Nuclear magnetic resonance, Moessbauer effect, atomic beams, optical hyperfine, perturbed angular correlations, electron paramagnetic resonance, nuclear specific heats, and other methods are treated. Twenty-five articles are included and separate abstracts were prepared for twenty-four. The paper on the Moessbauer effect in dilute Fe-alum was not abstracted. (M.H.R.)

For abstracts of individual papers see: 9097–9115, 9436–9439, and 9982.

9097 HYPERFINE STRUCTURE AND ELECTRON PARAMAGNETIC RESONANCE. Bleaney, B. (Oxford Univ.). pp 1-51 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

To illustrate the physical principles involved in the theory of hyperfine structure, a classical description of the interactions is given. Topics covered are: magnetic hyperfine interaction, electrostatic hyperfine interaction, paramagnetic ions in solids, and the paramagnetic resonance spectrum. 16 references. (M.H.R.)

9098 HARTREE–FOCK THEORY OF ELECTRIC AND MAGNETIC HYPERFINE INTERACTIONS IN ATOMS AND MAGNETIC COMPOUNDS. Watson, R. E. (Brookhaven National Lab., Upton, N. Y.); Freeman, A. J. Contract AT(30-2)-gen-16. pp 53-94 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967. (BNL-11124).

Some basic aspects of Hartree–Fock theory and the so-called unrestricted Hartree–Fock approximations are reviewed, as related to magnetic and electric quadrupole hyperfine interactions. Emphasis is on new developments involving the various unrestricted Hartree–Fock approximations and the experimental consequences of core polarization effects (closed shell distortions) for both magnetic and electric hyperfine fields. Recent aspects of the theory of magnetic hyperfine interactions in magnetic ionic compounds (transferred hfs and super-transferred hfs) are reviewed. The relevance of some of these matters to hyperfine effects in metals are briefly noted. 60 references. (M.H.R.)

9099 CALCULATIONS OF MAGNETIC HYPERFINE CONSTANTS FOR THE GROUND STATES OF SOME LIGHT ATOMS. Moser, C. M. (Centre de Mecanique Ondulatoire Appliquee, Paris). pp 95-113 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Some of the ab initio calculations that have been carried out on the magnetic hyperfine constants of the ^2S ground state of Li, the ^4S ground state of N and the ^3P ground state of O are discussed. 26 references. (M.H.R.)

9100 HYPERFINE STRUCTURE IN ATOMIC BEAM RESONANCE. Sandars, P. G. H. (Oxford Univ.); Dodsworth, Barbara. pp 115-39 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Current experimental techniques and applications of atomic beam resonance are considered and the theory of hyperfine structure in free atoms is discussed. (M.H.R.)

9101 OPTICAL HYPERFINE MEASUREMENTS. Steudel, A. (Technische Hochschule, Hanover). pp 141-224 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Material is presented on the elementary theory of optical hyperfine structure measurements, the determination of nuclear spins and nuclear magnetic dipole moments, the Fabry–Perot spectrometer, nuclear magnetic moment of ^{187}Os, hyperfine splitting of the configuration $4f^7(^8S)6s6p$ in Eu, application of atomic beams to optical hfs investigation of ^{55}Mn, applications of the double Fabry–Perot spectrometer to study of hfs of $^{185,187}Re$, isotope shifts, and level crossing. 51 references. (M.H.R.)

9102 SPECIAL TOPICS IN HYPERFINE STRUCTURE IN EPR. Geschwind, S. (Bell Telephone Labs., Murray Hill, N. J.). pp 225-86 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Material is included on electron-nuclear double resonance (ENDOR), paramagnetic shielding of nuclear moments, higher order Bleaney–Koster terms in the spin Hamiltonian, zero-point spin deviation in antiferromagnets and some systematics of core polarization hyperfine fields in $3d^n$ ions, exchange coupled spectra, and optical detection of excited state EPR. 63 references. (M.H.R.)

9103 NUCLEAR MAGNETIC RESONANCE IN MAGNETIC AND METALLIC SOLIDS. Narath, Albert (Sandia Corp., Albuquerque, N. Mex.). pp 287-363 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Two general areas of magnetic hyperfine studies are treated, namely NMR in magnetic solids and in metals, together with a review of the necessary elementary magnetic resonance theory. 64 references. (M.H.R.)

9104 NUCLEAR SPECIFIC HEATS IN METALS AND ALLOYS. Lounasmaa, O. V. (Technical Univ. of Helsinki). pp 467-96 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

One of the methods for investigating hyperfine interactions in ferro- and antiferromagnetic metals and alloys involves measurements of the so-called nuclear or hyperfine specific heat C_N. These experiments, their interpretation, and some of the results obtained are presented. The theory involved is discussed and the relevant formulas for C_N are presented. The components of the measured total specific heat C_p and the separation of C_N are examined. Experimental techniques are discussed briefly and specific heat measurements are compared with other methods for investigating hyperfine interactions. Experimental results are presented and discussed, first on transition metal and their alloys and then on rare earth metals. 52 references. (M.H.R.)

9105 RECOILLESS ABSORPTION OF GAMMA RAYS AND STUDIES OF NUCLEAR HYPERFINE INTERACTIONS IN SOLIDS. Moessbauer, R. L.; Clauser, M. J. (Technische Hochschule, Munich). pp 497-551 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Topics covered are: principles of recoilless nuclear resonance absorption, the experimental technique, observations of recoilless nuclear resonance, the isomer shift, and hyperfine interactions. (M.H.R.)

9106 HYPERFINE INTERACTIONS AND THE ANGULAR DISTRIBUTION AND CORRELATIONS OF NUCLEAR γ RAYS.

Cohen, S. G. (Hebrew Univ., Jerusalem). pp 553-93 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

The perturbation, by hyperfine fields in solids, of angular correlation or angular distribution patterns of γ rays emitted from excited states of nuclei in solids, either formed in the process of radioactive decay, or in nuclear reactions, is discussed. Some attention is given to the information on hyperfine interactions which can be obtained from the investigation into the degree of nuclear orientation in solids at low temperatures. This may be investigated either by measuring the angular distribution of nuclear radiations, in the case of radioactive nuclei, or, by measuring the transmission of polarized neutron beams by the solid containing an appreciable percentage of oriented nuclei, in the case of stable nuclei. (M.H.R.)

9107 STUDIES OF HYPERFINE INTERACTIONS IN FERROMAGNETIC ALLOYS BY INTEGRAL ANGULAR CORRELATION TECHNIQUES. Karlsson, Erik (Inst. of Physics, Uppsala). pp 627-36 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

In order to obtain measurable interactions down to the picosecond region the large hyperfine fields present at the nuclei of paramagnetic ions or of atoms introduced as dilute impurities in ferromagnetic Fe, Ni, Co, or Gd are used. Some recent experiments with nuclei in ferromagnetic iron hosts are discussed. It is shown that the integral PAC (perturbed angular correlation) method is sometimes capable of relatively high accuracy and that it can be applied to many elements, like the magnetically important palladium, for which the Moessbauer effect and differential PAC cannot be used for the study of hyperfine fields. The examples presented deal with ^{193}Ir, ^{106}Pd, and ^{122}Te in iron matrices and the potential use of ^{127}I as a case for the comparison and combination of PAC and Moessbauer techniques. (M.H.R.)

9108 COULOMB-EXCITATION ION-IMPLANTATION PERTURBED ANGULAR CORRELATION METHOD. Murnick, Daniel (Massachusetts Inst. of Tech., Cambridge). pp 637-49 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Using the large anisotropy of gamma radiation emitted from Coulomb excited nuclei, in coincidence with backscattered exciting particles, the hyperfine interactions of nuclear moments can be studied with the internal electromagnetic fields of solid-state environments. The Coulomb-excitation ion-implantation method has been most fruitful in hyperfine interaction problems. The experimental arrangement at the Wisconsin Tandem Accelerator is described in some detail. The physical processes taking place in the preparation and decay of the nuclear states studied are commented on. The capabilities of the method are illustrated with some recent results obtained implanting samarium-150 into various lattices. (M.H.R.)

9109 A STUDY OF RARE-EARTH HYPERFINE STRUCTURES USING COULOMB-EXCITED MOESSBAUER LEVELS. Walker, J. C. (Johns Hopkins Univ., Baltimore). pp 650-8 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Attention is restricted to the 2+ → 0 transition in the even–even rare earth isotopes. Several even–even isotopes of ytterbium are studied, namely ^{170}Yb, ^{172}Yb, ^{174}Yb, and ^{176}Yb. Electric hyperfine spectra were obtained for the 2+ nuclear levels of these isotopes in Yb_2O_3. (M.H.R.)

9110 SOME LOW-TEMPERATURE NUCLEAR ORIENTATION TECHNIQUES AND APPLICATIONS. Stone, N. J. (Oxford Univ.). pp 659-72 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

The theory and technique of the nuclear orientation method is outlined and some idea of its scope and limitations is given. A brief account of nuclear orientation studies at the Clarendon Laboratory, Oxford, is given. The main object in those studies is the measurement of hyperfine interactions at paramagnetic ions of the iron group present as dilute impurities in metals which, in their pure state, are nonmagnetic. Experiments to extend the systematic study of hyperfine fields at diamagnetic impurities in ferromagnets are described also. (M.H.R.)

9111 ROTATIONAL COOLING AND NUCLEAR RELAXATION IN A DILUTE PARAMAGNETIC CRYSTAL. Lubbers, J. (Univ. of Leiden). pp 673-8 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Manganese-54 in (Ce–La) Mg nitrate was studied at low temperatures. A two-stage cooling process was used consisting of: (1) precooling the sample by a cooling salt outside the field region, while a magnetic field is applied in the direction of the large g-value, and (2) rotating the field to a low g-value direction, thus demagnetizing the Ce spins. The degree of nuclear orientation of the ^{54}Mn spin system was calculated from the observed γ-ray anisotropy, which was measured by observing the intensity of the γ rays emitted in the direction of the magnetic field. (M.H.R.)

9112 MAGNETIC RELAXATION EFFECTS IN MOESSBAUER SPECTRA. Dekker, A. J. (Univ., Groningen, Netherlands). pp 679-90 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

The subject of relaxation effects in Moessbauer spectra is introduced, particularly with reference to the magnetic hyperfine splitting. Iron-57 is used as a specific example. The consequences of a simple model employed previously in the interpretation of experimental data are outlined briefly. Effects in ferro- and antiferromagnetic materials and extension to the case of $S = 5/2$ are discussed. (M.H.R.)

9113 POLARIZED RECOIL-FREE GAMMA RAYS. Gonser, U. (North American Aviation Science Center, Thousand Oaks, Calif.). pp 696-711 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

The discussion is restricted to magnetic dipole radiation, particularly to the 14.4-keV γ ray of the first excited state of ^{57}Fe. The energy levels of the ground state and first excited state of ^{57}Fe for a pure magnetic hyperfine interaction and a pure axially symmetric quadrupole interaction are shown. The angular dependence of the γ radiation for allowed transitions in the hyperfine Zeeman spectrum is tabulated. It is shown how the spin orientation in a magnetic material or the axis of the electric field gradient in a crystal can be determined from the angular dependences. (M.H.R.)

9114 ELECTRONIC STRUCTURE AND HYPERFINE FIELDS IN METALLIC ALLOYS. Daniel, E. (Institut de Physique, Strasbourg). pp 712-23 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

The connection between observed hyperfine fields in metallic alloys and some of the concepts most useful in describing their electronic structure is shown. These concepts are the screening of positive ionic charge by the conduction electrons and the corresponding phase shifts in partial waves, giving rise to long-range oscillations of charge or spin density. The special case of virtual bound states which can give rise to localized moments is considered, and its successful application to Heusler alloys is shown. Some comments on binary alloys of transition metals are made. The spin polarization of conduction electrons in iron, as deduced from measurements of the hyperfine field at the nuclei of nonmagnetic impurities, is discussed. (M.H.R.)

9115 ELECTRIC FIELD PERTURBATIONS OF HYPERFINE INTERACTIONS. Reichert, Jonathan F. (Western Reserve Univ., Cleveland). pp 745-51 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Methods of producing external perturbations of hyperfine interactions are discussed. The effects in solids as measured by spin resonance are the main concern here. (M.H.R.)

9116 HANDBOOK OF PHYSICS. SECOND EDITION. Condon, E. U.; Odishaw, Hugh (eds.). New York, McGraw-Hill Book Co., 1967. 1710p. $32.50.

Discussions are given on various aspects of the following general headings: (1) mathematics, (2) mechanics of particles and rigid bodies, (3) mechanics of deformable bodies, (4) electricity and magnetism, (5) heat and thermodynamics, (6) optics, (7) atomic physics, (8) the solid state, and (9) nuclear physics. (M.O.W.)

9117 CHARGED PARTICLE SOURCES. (to C S F Compagnie Generale de Telegraphie Sans Fil). British Patent 1,094,738. Dec. 13, 1967. Priority date Mar. 1, 1965, France.

The present invention relates to sources of charged particles, which may be either ions or electrons, in which the particles emerge from an orifice in the wall of a cavity formed by a hollow body. The cavity is filled with a plasma. (M.O.W.)

Cosmic Radiation

Refer also to abstracts 8627, 8856, 8868, 8869, 8898, 8942, 8950, 8961, 9413, and 9503.

9118 (AECL–2789) COSMIC RAY NM-64 NEUTRON DATA-Ia FROM DEEP RIVER, ONTARIO, APRIL 1962–JANUARY 1965.

Monthly Graphs, April 1962–December 1963. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1967. 131p. Dep. CFSTI. CAN.

Uncorrected and barometer-corrected results from the Deep River neutron monitors are given in tabular form for the period from April 1962 to January 1965. Normalized monthly graphs are included from April 1962 to December 1963. The graphs for the period January 1964 to April 1966 are available in Cosmic Ray NM-64 Neutron Monitor Data-III (AECL-2598). (auth)

9119 THE HAVERAH PARK EXTENSIVE AIR SHOWER ARRAY. Tennent, R. M. (Univ. of Leeds, Eng.). Proc. Phys. Soc. (London), 92: 622-31(Nov. 1967).

The experimental facilities offered by the Haverah Park extensive air shower array are described. This array contains four deep Cherenkov detectors, each of area 34 m^2, spaced 500 m apart. The response of the detectors to the different components of the cosmic radiation is described and the performance of the array as a whole is considered. The array is efficient in detecting showers from primary particles having energies in the range 10^{17} to 10^{18} eV and responds efficiently to showers arriving at large zenith angles. (auth) (UK)

9120 MEASUREMENT OF THE INTENSITY OF NUCLEAR-ACTIVE PARTICLES AT THE MOUNTAIN ALTITUDES. Babayan, Kh. P.; Boyadzhyan, N. G.; Grigorov, N. L.; Mamidzhanyan, E. A.; Sobinyakov, V. A.; Shestoperov, V. Ya. (Erevan Inst. of Physics. Moscow State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 207-11(1967). (In Russian).

The results of an investigation of the absolute flux of nuclear-active particles at mountain altitudes by the ionization calorimeter method are given. The integral energy spectrum of the nuclear-active particles as well as the integral energy spectrum of single nuclear-active particles in the air at 3200 m above sea level are obtained. (auth)

9121 PRIMARY COSMIC-RAY ELECTRONS BELOW 600 MeV. Simnett, G. M. (Imperial Coll. of Science and Tech., London). Planet. Space Sci., 15: 1787-98(Nov. 1967).

The primary cosmic-ray electron flux between 25 and 600 MeV was measured with a system composed of a Cherenkov telescope and a scintillation detector, separated by lead absorber. A modified detector was employed to investigate the primary electron differential energy spectrum. Results are presented from balloon flights made from Kiruna, Northern Sweden, and Cardington, England, between 1964 and 1966. The flights from England specifically investigated the atmospheric secondary electron component, and these measurements are compared with recent theoretical calculations. The Kiruna observations are corrected for atmospheric secondary electrons, using both the theoretical and experimental data. The results are well represented between 25 and 500 MeV by a power law spectrum of the form: $dJ/dE = 12^{+4.5}_{-3.5}$ $E^{-0.6\pm0.2}$ electrons/m^2 sec sr MeV. A comparison is made with the results of other investigators. The origin of low energy primary electrons is discussed and emphasis is placed on the galactic "secondary" source in the energy range under observation. (auth) (UK)

9122 COSMIC-RAY DIFFUSION, ENERGY LOSS, AND THE DIURNAL VARIATION. Parker, E. N. (Univ. of Chicago. California Inst. of Tech., Pasadena). Planet. Space Sci., 15: 1723-46(Nov. 1967).

Consideration is given to a number of points pertaining to the origin of the observed mean diurnal variation of the cosmic-ray intensity, which were not treated in earlier papers on the subject. Following a brief review of the basic nature of the diurnal variation, the necessary diffusion across the lines of force is investigated. It is found that the values $\kappa_\perp/\kappa_{||} \cong 10^{-2}$, deduced from the observed fluctuations inside the orbit of earth, give about the right amount of diffusion to account for the fact that the amplitude of the diurnal variation is approximately half the theoretical upper limit, which would apply if $\kappa_\perp$ were much larger. The calculations show that the geometry of the spiral form of the field beyond the orbit of earth plays an essential role in providing sufficient diffusion across the lines of force. The calculations also show that variation in outer radius R and in $\kappa_\perp/\kappa_{||}$ due to changing wind conditions may contribute to some of the observed changes in the amplitude of the diurnal variation. The diurnal variation is rederived for steady uniform wind conditions in order to include the effect of adiabatic deceleration. The effect is the addition of a small diurnal component with an amplitude proportional to the radial cosmic-ray gradient in space. The effect is only a few per cent of the total diurnal variation above 1 GeV, and hence may be neglected in that case. The effect is large at low energies, but is not subject to observation. The principal observable steady diurnal variation is, then, the rotation of the cosmic rays with the sun. A summary of the motion of a particle in an idealized smooth spiral interplanetary field is included, with a discussion of the energy loss from adiabatic expansion. (auth) (UK)

9123 DEVIATION OF OBSERVED MUON DIRECTION FROM PRIMARY DIRECTION DUE TO GEOMAGNETIC FIELD. Berkal, A.; Hung, E. K. L.; Coish, H. R. (Univ. of Manitoba, Winnipeg, Can.). Can. J. Phys., 45: 4113-15(Dec. 1967).

A computer program was written to compute the correction for any latitude and viewing direction using numerical iterative procedures. The calculation can be performed for any observational station. A distribution curve such as that found in this investigation could be used to correct for deviations of the observed muon directions from the directions of the primary particles. (F.S.A.) (CANADA)

9124 SOLAR MODULATION AND THE GALACTIC INTENSITY OF COSMIC-RAY POSITRONS AND NEGATRONS. Ramaty, Reuven (Goddard Space Flight Center, Greenbelt, Md.).; Lingenfelter, Richard E. Phys. Rev. Lett., 20: 120-4(Jan. 15, 1968).

It is shown, on the basis of a more accurate secondary electron calculation, that the observed positron flux is entirely consistent with such a secondary origin and that no primary positron sources are required. Therefore, it is suggested that, from the comparison of the calculated and observed positron intensities, it is possible to evaluate the residual solar modulation of positrons, and also of electrons, since the modulation of electrons is probably the same as that for positrons. Then, from the observed total electron flux at the Earth, the electron modulation, and the calculated secondary electron intensity, it is possible to deduce the primary electron spectrum in interstellar space. (W.D.M.)

9125 TWO-WAYS SIDEREAL ANISOTROPY. Nagashima, K. (Nagoya Univ., Japan); Mori, S. Uchusen-Kenkyu, 12: 179-85(Sept. 1967).

Sidereal time variation is analyzed by using data of the ion chamber at Cheltenham and Christchurch for the period of 1938 to 1958 and of the meson and neutron components during IGY. All the results derived from these three kinds of data support the existence of a two-ways sidereal anisotropy, suggested by Jacklyn, which has two maxima of the cosmic-ray intensity in the direction of 8 hr and 20 hr S.T. (sidereal time). (NSA of Japan)

9126 SECONDARY COSMIC-RAY ELECTRONS PRODUCED IN INTERSTELLAR MEDIUM. I. GALACTIC SECONDARY ELECTRON SOURCES. Perola, G. C.; Scarsi, L.; Sironi, G. (CNR, Milan). Nuovo Cim. (10), 52B: 455-68(Dec. 11, 1967).

Detailed calculations were made on the energy spectra of the electrons and positrons produced in the interactions between the nucleonic component of cosmic rays and the interstellar medium. The dominant sources are represented by the knock-on electrons and the decay chain $\pi^\pm \rightarrow \mu^\pm \rightarrow e^\pm$. For the latter process the calculations were based on a pion-source spectrum obtained using accelerator data on the basic nuclear interaction from the production threshold up to 30 GeV for incident protons and reasonable extrapolations at higher energies. The uncertainty on the results is essentially related to the errors in the data on the nuclear interactions, the poor details available for interactions of protons with energies above 30 GeV and the assumptions made on the interaction between multinucleon particles. The precision of the numerical values obtained is estimated at better than 20% for electrons up to a few GeV. Allowing for the incomplete knowledge of the cosmic-ray spectrum at low energies in the Galaxy, the calculations were made for two spectra: the first coincident with that observed near earth at solar minimum, the second described by a power law $N(W) = KW^{-\gamma}$ with $\gamma = 2.5$. The differences in the corresponding electron source spectra are appreciable below 1 MeV and between 50 and 100 MeV. (auth)

9127 ANISOTROPY OF GALACTIC COSMIC RAYS. Kovar, R. P.; Dessler, A. J. (Rice Univ., Houston, Tex.). Astrophys. Lett., 1: 15-16(Sept. 1967).

The purpose of this letter is to suggest another possible source of galactic cosmic-ray anisotropy besides those already noted by others. The effect is not galactic in nature, but is associated with the motion of the Sun through the local portion of the Galaxy. As is known, the Sun is moving at a velocity of 20 km/sec with respect to the local interstellar medium. This relative motion will lead to a distortion of the region where the solar wind merges with the interstellar medium. (W.D.M.)

9128 THE MONTE CAPPUCCINI, UNDERGROUND LABORATORY FOR COSMIC RAYS. Castagnoli, Carlo; Castagnoli, Giuliana Cini; Dodero, Adele (Univ., Turin. CNR, Turin). Ric. Sci., 37: 499-508(June 1967). (In Italian).

A new underground laboratory for cosmic-ray studies is described. It is situated outside Turin at a depth of 70 m. Particulars are given of the characteristics of the station which is equipped for the permanent study of intensity variations of the muon component at this depth. (auth)

9129 RADIATION AND SHIELDING IN SPACE. Haffner, James W. Nuclear Science and Technology, a Series of Monographs and Textbooks. New York, Academic Press, 1967. 355p. $17.50.

Separate abstracts were prepared for the 9 included chapters. (M.O.W.)

For abstracts of individual chapters see: 8627, 8936, 9130, 9227, and 9412–9416.

9130 GALACTIC (COSMIC) RADIATION. pp 45-75 of Radiation and Shielding in Space. Haffner, James W. New York, Academic Press, 1967.

Discussions are presented on the following: (1) brief history, (2) mass distribution, (3) energy spectra, (4) time variations, (5) spatial distribution, (6) interactions with Earth, and (7) theories. 127 references. (M.O.W.)

Direct Energy Conversion

Refer also to abstracts 9255 and 9430.

9131 LIQUID-PHASE MHD AND THE TECHNOLOGY OF ALKALI METALS. Porte, D. Rev. Gen. Elec., 76: 923-6(June 1967). (In French).

According to the cycles presently proposed for liquid metal MHD, the temperature of the heat supply should be between 800°C and 1200°C when alkali metals are used. The present technology of Na does not allow temperatures exceeding 600°C to be used, and studies of material structure must be carried out to attain the desired temperatures. The lack of data should not hinder development of the technique. A few units connected with MHD, i.e., pumps and electromagnetic flowmeters, are described. The most important problems concerning the MHD generator itself are its construction, its performance, calculations related to its performance, and the validity of the proposed thermodynamic cycles. (BBB)

9132 EXPERIMENTAL STUDIES ON THE POWER TRANSFER BETWEEN A SODIUM JET AND A SLIDING-FIELD ARMATURE. Quichaud, G.; Le Frere, J.-P. (Laboratoire Central des Industries Electriques, Paris). Rev. Gen. Elec., 76: 915-22(June 1967). (In French).

A trial MHD generator is described. Measurement circuits constructed for the study of power transfer between the liquid jet and the inductor winding are presented. Results of tests at 50 Hz and 17 Hz frequencies are given. The technological problems presented by construction of liquid jet MHD generators on a commercial scale are discussed. The generator possesses the following advantages: the fluid circulates in a circular tube, thus gaining mechanical superiority; Cu bars are suppressed, because the current lines in the liquid metal become circular and close on themselves; and a geometry which is well adapted to the construction of units in which important output is achieved. The disadvantages include the inconveniences of working at liquid temperatures, cooling in a magnetic core, lack of choice of canal dimensions in a small unit, and difficulties with demounting and accessibility. (BBB)

9133 LIQUID-JET MAGNETOHYDRODYNAMIC CONVERTERS. Bonnefille, R.; Chevallier, G. (Univ., Paris). Rev. Gen. Elec., 76: 891-7(June 1967). (In French).

Development of liquid jet magnetohydrodynamic converters, although based on the propositions of Arago and Faraday at the beginning of the 19th century, was not achieved until recently, and then using liquid metals or alloys. The fundamental equations are developed from electromagnetism, electrokinetics, and hydrodynamics. The principal types of alternating current electric generators and continuous current generators are described, and the pertinent electrical and thermodynamic problems attached to each are discussed. MHD conversions in liquid jets and plasmas are compared. The first is not weakened by technological problems in material containment and alternating current generation, while the second has a simpler thermodynamic cycle and gives a better theoretical yield. It is possible that the two types will be used in conjunction in the future. (BBB)

9134 MAXIMUM VOLTAGE VALUES FOR D-C MGD GENERATOR. Lavrent'ev, I. V. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 152-4(1967). (In Russian).

Considering that the low voltage of a direct-flow, liquid-metal, dc MHD generator (caused by the high conductance of the liquid metal) constitutes its main deficiency, an attempt was made to increase the voltage by installing at the end zones of the channel some nonconducting partitions with their planes parallel to the magnetic induction vectors and liquid velocities. Results indicate that, in spite of increased hydraulic losses and losses on magnetic field excitation, the voltage of the generator is increased. (R.V.J.)

9135 ISOTHERMIC MHD CONVERTER WITH SERIES CONNECTION OF ELECTRODES. El'kin, A. I. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 91-4(1967). (In Russian).

The isothermal flow of gas in an MHD converter with series connection of electrodes was examined in the quasi-one-dimensional approximation. Calculation was made of the optimization of the isothermal MHD converter for constant electric output. (tr-auth)

9136 PRELIMINARY STUDIES ON A SLIDING-FIELD LIQUID-VEIN MHD GENERATOR. Kant, Michel; Robert, Jack (Centre National de la Recherche Scientifique, Paris). Rev. Gen. Elec., 76: 906-14(June 1967). (In French).

Reasons for the study of a sliding field liquid vein MHD generator are outlined. The usual vector potential expression is developed, by inclusion of the usual magnetohydrodynamic considerations, into a programmable expression for the induction. This results in an electric model from which the conditions for operation of an MHD generator may be defined. The theoretical basis for a generator is defined; its construction is reported elsewhere. Preliminary measurements indicate that the finite size of the generator is related to an idealized distribution of rotor currents, in agreement with calculations. The finite magnetic circuit is composed of three parts, only the central one being wound. Theoretically only the central part has a sliding field. End effects are attenuated by a non-wound part at the end and entrance to the canal. (BBB)

9137 OPTIMUM MHD GENERATOR WITH A CONSTANT CHANNEL CROSS SECTION. Pleshanov, A. S.; Lazarev, P. P. (Power Engineering Inst., Moscow). Teplofiz. Vys. Temp., 5: 907-12(Sept.-Oct. 1967). (In Russian).

By using the quasi-one-dimensional approximation at small magnetic Reynolds number, the precise complete solution of the variational problem in optimization of the linear conduction MHDH with constant cross section surface of the channel S is obtained. The optimization is realized by obtaining the given output N in minimum generalized volume Δ (parameter of magnetohydrodynamic interaction) which is also obtained with the maximum N at a given value Δ. An ideal nonviscous and non-heat-conducting electroconducting gas was the working substance. The gas conductivity depends on the temperature, pressure, and magnetic and electric fields. A comparison is made of the maximum index of the optimum MHD and MHDH with physical parameters. (tr-auth)

9138 RECENT DEVELOPMENTS IN CLOSED-CYCLE PLASMA MHD SYSTEMS. Jackson, William D. (Univ. of Illinois, Chicago). Power Reactor Technol. Reactor Fuel Process., 10: 136-47(Spring 1967).

The current status of MHD generators is briefly reviewed. Recent developments are briefly discussed on closed-cycle MHD experiments, nonequilibrium theory and measurements, MHD instabilities, auxiliary ionization and recombination, and conformal mapping and electrode leakage. Future prospects for MHD generators are discussed. (M.O.W.)

9139 MAGNETOHYDRODYNAMICS AND POWER GENERATION. Rotherham, L. Nature (London), 216: 1071-2(Dec. 16, 1967).

A brief review is given of the CEGB's magnetohydrodynamic programme for the generation of electricity. (UK)

9140 GRAPHICAL PRESENTATION OF MAGNETOGASDYNAMIC ACCELERATOR AND GENERATOR PERFORMANCE CHARACTERISTICS. Powers, W. L.; Dicks, J. B.; Snyder, W. T. (Univ. of Tennessee Space Inst., Tullahoma). Contracts AF 40(600)-1000; AF 33(615)-2691. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 2232-6(Dec. 1967).

A graphical display of the generalized Ohm's law which is assumed to describe the local electrical characteristics of magnetogasdynamic (MGD) accelerators and generators is presented. Dimensionless electric fields and current densities are defined which simplify the problem and allow a dimensionless power density and a scaled efficiency to be written and presented on a performance map. The operating features of the continuous-electrode, Faraday, diagonal conducting wall, and Hall accelerators and generators are represented on the same map for purposes of comparison. The operating equations pertinent to each of the special devices are also written with more emphasis given to the diagonal conducting wall device. It is shown how this map may be used in evaluating MGD channel performance, and how it materially aids in channel design and in selecting the most desirable type device for a given requirement. (auth)

9141 MAGNETIC FIELD EFFECT ON SPACE-CHARGE NEUTRALIZATION IN ELECTRIC PROPULSION. Meyer, Rudolf X.; Kramer, Raymond F. (Aerospace Corp., Los Angeles). Contract AF 04(695)-1001. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 2201-7(Dec. 1967).

Some basic aspects of ion beam neutralization in the presence of magnetic fields are investigated. The problem leads to an integrodifferential equation for the electrostatic potential. This equation is solved numerically for several values of the electron–ion mass ratio. Of more interest for practical applications is the limit as the mass ratio tends to zero. In this case, the governing equation becomes linear and the problem reduces to finding the inverse of a Hilbert transform. The solution can be expressed in terms of elementary functions. Among the results obtained are the distribution of the charge densities for electrons and ions in the beam, and the electron trajectories. The limiting condition for beam reversal, which applies when the magnetic field is sufficiently strong to prevent the electrons from being drawn into the beam, is determined. Also computed is the loss in propulsive efficiency due to "electron-swirl." Finally, it is pointed out that this loss can be entirely avoided if a magnetic field is employed whose transverse component changes direction. (auth)

9142 IMPROVEMENTS IN OR RELATING TO MAGNETOHYDRODYNAMIC APPARATUS. Swift-Hook, Donald Thomas, Wright, John Keith; Maycock, John; Beecher, Bernard John (to Central Electricity Generating Board). British Patent 1,097,443. Jan. 3, 1968. Filed Mar. 19, 1964.

A duct for magnetohydrodynamic apparatus is described which is constructed of a number of metal tubes. Each tube is shaped to form a loop extending completely around the duct. The various loops are stacked together with electrical insulation between them to form a duct with each loop lying in a plane or other surface oblique to the axis of the duct. The portions of the tube in contact with the conductive fluid passing the duct may be used as electrodes. Magnetohydrodynamic apparatus comprising a duct for a conductive fluid and means for producing a magnetic field extending transversely across a duct is described. (M.H.R.)

9143 IMPROVEMENTS IN OR RELATING TO MAGNETOHYDRODYNAMIC ELECTRICAL GENERATORS. Swift-Hook, Donald Thomas (to Central Electricity Generating Board). British Patent 1,097,444. Jan. 3, 1968. Filed Mar. 20, 1964.

An MHD electric generator is described wherein a duct through which conductive gas flows has, on two opposite surfaces, similar series of axially spaced electrodes. In this duct electrical connections are provided between those electrodes of the two series which lie in the desired equipotential planes at an angle to the axis of the duct. There are some unconnected electrodes at one end of one series and at the opposite end of the other series; means are provided for connecting both ends of a main load through networks of subsidiary loads to the unconnected electrodes. The subsidiary loads in each network are proportioned in accordance with current flows to the various electrodes to which the network is connected, thereby allowing current to be drawn from or fed into these electrodes at the potential appropriate to the required potential distribution along the duct. (M.H.R.)

9144 MAGNETOHYDRODYNAMIC STUDIES IN CYLINDRICAL SYSTEMS WITH POWER GENERATION APPLICATIONS. McCutcheon, Martin Jack. Fayetteville, Ark., Univ. of Arkansas, 1967. 135p.
Thesis.

The analysis of an annular induction magnetohydrodynamic generator from a field theory approach has been made in order to determine the phase impedance, the power factor and the performance characteristics for the model. The flow velocity is assumed constant in the analysis in order to uncouple the electromagnetic and hydrodynamic equations; the resulting solution accounts for the effects of curvature introduced by the geometry; both open channel flow and annular channel flow are considered. The generator phase impedance and power factor are presented in normalized scalable form in terms of the dimensions, excitation, and flow parameters. Several examples are given for both ionized gas and liquid metal flows which illustrate the performance levels which should be achieved with the generator. The results indicate that it may be feasible to construct an experimental generator with liquid metal as the working fluid. The development of a conductivity probe which can be used with an electric shock tube is described also. The probe circuitry and its advantages are discussed and some experimental measurements are compared with established theoretical values for argon. (Disser. Abstr.)

9145 MASS FLOW FLUID GENERATOR. (to Varian Associates). British Patent 1,097,858. Jan. 3, 1968. Priority date Apr. 8, 1965, United States.

A mass-flow fluid generator for converting thermal energy to electrical energy is described. It comprises a fluid supply means adapted to direct a stream of high-velocity electrically conductive fluid. A duct is connected to said fluid supply means so as to form a longitudinal passageway for the directed fluid stream. Synchronizing means are associated with said duct and are adapted to provide along the length thereof an electromagnetic-wave-supporting structure for interaction between the electric fields of wave energy on the structure and the high-velocity electrically conductive fluid stream so as to cause modulation and charge separation of the stream. Output means are provided for receiving alternating current energy converted from the kinetic energy content of the modulated high-velocity fluid stream passing through said duct. (M.H.R.)

9146 IMPROVEMENTS IN OR RELATING TO THE GENERATION OF ELECTRICITY WITH HALL CURRENT GENERATORS. (to Avco Corp.). British Patent 1,097,530. Jan. 3, 1968. Priority date Feb. 23, 1965, United States.

A method of generating electricity with a Hall current generator is described in which a hot electrically conductive gas flows through a magnetic field perpendicular to the magnetic flux lines. This is to induce so-called "normal" currents which close on themselves within the gas stream as well as Hall currents which flow in the stream direction to terminal electrodes connected to external circuit means. An annularly shaped magnetic field is employed having magnetic lines of flux parallel to the axial dimension of the field and the flow of gas past the terminal electrodes is caused to be radially outward from the inner periphery to the outer periphery of the field. (M.H.R.)

Fluid Physics

Refer also to abstracts 9135, 9221, and 9324.

9147 THE NONLINEAR EFFECT OF FORMATION OF A SELF-SUSTAINING HIGH-TEMPERATURE ELECTRICALLY CONDUCTING GAS LAYER IN NONSTATIONARY PROCESSES OF MAGNETOHYDRODYNAMICS. Tikhonov, A. N.; Samarskii, A. A.; Zaklyaz'minskii, L. A.; Volosevich, P. P.; Degtyarev, L. M.; Kurdyumov, S. P.; Popov, Yu. P.; Sokolov, V. S.; Favorskii, A. P. Dokl. Akad. Nauk SSR, 173: 808-11(Apr. 1, 1967). (In Russian).

In the investigation of nonstationary processes of the interaction of an incompressible electrically conducting medium with a magnetic field it has been found that there is a self-sustaining high-temperature conductive layer (the T layer) which arises because of the predominant evolution of Joulean heat in a certain gas mass. In its physical nature this phenomenon resembles the familiar skin effect and phenomena of dissipative instability in magnetohydrodynamics, but it does not reduce to either of these and differs essentially from them. An examination is made of the conditions under which the T layer originates and develops. The effect detected is of a general physical nature, but the work shows certain particular solutions of equations of unidimensional instability in MHD which demonstrate the existence of the effect in question and illustrate its main characteristics. Formation of the T layer was demonstrated and studied on a mathematical model taking into consideration in their essential features the nonlinear relationships of nonstatonary processes in MHD. Discussions are included on the autosimulation problem of the expansion of a conductive gas in a magnetic field, such as expansion from a certain initial state, and decay of MHD discontinuity in a medium of finite conductivity. (ATD)

9148 HEAT EXCHANGE IN TURBULENT MOTION IN THE PRESENCE OF A TRANSVERSE HOMOGENEOUS MAGNETIC FIELD. Ozols, R. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 87-92(1967). (In Russian).

Heat exchange in a flat duct filled with an incompressible electroconducting liquid moving in a stable turbulent regime is considered. Turbulent viscosity is constant across the duct and the walls of the duct are isothermal. The influence of the transverse homogeneous magnetic field on the heat exchange at a constant liquid flow rate is presented. The values of the outer magnetic field and the electroconductivity of the walls are found to exercise a great influence upon the liquid temperature and Nusselt's number characterizing the heat exchange. (auth)

9149 THEORY OF HEAT AND MASS TRANSFER. Mikhailov, Yu. A. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 32-6(1967). (In Russian).

Investigations in the theory of heat and mass transfer in disperse and other media developed at the Institute of Physics and Energetics of the Academy of Sciences of the Latvian SSR in the period of 1953–1966 are reviewed. Theoretical investigations are employed in the substantiation of series of methods for high-temperature drying processes. Experimental and analytical investigations of heat and mass transfer in electroconductive media, particularly in two-phase systems in the presence of electrical and magnetic fields, are presented. (auth)

9150 ON NORMAL VORTICITY AND CURRENT DENSITY GENERATED BEHIND A MAGNETOGASDYNAMIC SHOCK WAVE IN UNSTEADY FLOWS. **Ram, Rishi (Univ. of Allahabad, India). J. Fluid Mech., 30: 805-8(Dec. 22, 1967).**

Two interesting linear relations between normal vorticity and current density generated behind a shock wave in three-dimensional unsteady flows of conducting gases were investigated in order to determine them purely from dynamical considerations. Some interesting physical conclusions are also made. (auth) (UK)

9151 MEASUREMENTS OF DRAG IN A CONDUCTING FLUID WITH AN ALIGNED FIELD AND LARGE INTERACTION PARAMETER. **Yonas, G. (California Inst. of Tech., Pasadena). J. Fluid Mech., 30: 813-21(Dec. 22, 1967).**

The drag of spheres and disks was measured in a flow of liquid sodium within an aligned magnetic field. A slightly viscous, strong field limit is discussed and was explored experimentally. In this limit the drag coefficient was found to have an asymptotic dependence proportional to the square root of the interaction parameter, the ratio of magnetic to inertial force, independent of body shape. A physical model is presented along with preliminary verification of its basic characteristics. (auth) (UK)

9152 STABILITY OF A SELF-GRAVITATING FLUID LAYER. **Tassoul, J. L. Mon. Notic. Roy. Astron. Soc., 137: 1-13(1967).**

The stability of a self-gravitating incompressible fluid layer of finite thickness is considered. It is shown that a uniform magnetic field extending throughout the whole space and an external conducting fluid have a strong stabilizing influence, but cannot remove entirely the instability with respect to disturbances of very long wavelengths. On the other hand, in the absence of a magnetic field, an outer medium and a differential rotation are able to remove the gravitational instability when the angular velocity of rotation is larger than a certain critical value. When a magnetic field, however, is impressed on the disk a uniform rotation cannot entirely remove the instability of the system; moreover, in this case, the coupling between the Coriolis force and the Lorentz force allows purely hydromagnetic oscillations. It is also shown that the influence of the magnetic field is reduced when allowance is made for finite electrical conductivity. Lastly, viscosity decreases the growth rate of the gravitational instability and shifts the mode of maximum instability towards long wavelengths. (auth) (UK)

9153 KELVIN INSTABILITY FOR ROTATING COMPRESSIBLE HYDROMAGNETIC FLUIDS. **Kalra, G. L.; Talwar, S. P. Mon. Notic. Roy. Astron. Soc., 135: 391-400(1967).**

The problem of stability of uniformly rotating superposed compressible hydromagnetic fluids forming a vortex sheet is investigated. It is found that a small rotation (parallel to the velocity discontinuity) present alone, or along with the magnetic field, has a stabilizing influence for long wavelength perturbations. A density discontinuity is also found to have a stabilizing effect on the configuration. The magnetic field, if transverse to the direction of streaming of compressible fluids, is destabilizing, in contrast to its stabilizing role for the case of the streaming motion parallel to the field. (auth) (UK)

9154 EXACT SOLUTIONS OF THE EQUATIONS FOR HYPERCRITICAL FLOW IN MAGNETOGASDYNAMICS. **Obermeier, Frank (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Ger.). Z. Flugwiss., 15: 13-16(1967). (In German).**

A set of differential equations is presented for a stationary, isoenergetic flow of an ideal electrically conducting, nonviscous, isoentropic, and compressible medium in a parallel magnetic field. This system of approximate equations for hypercritical, weakly perturbed parallel flow of magnetogasdynamics in the plane case and the case of rotational symmetry was reduced to 1 ordinary differential equation by means of a similarity solution. The solutions of this differential equation can be determined explicitly for certain values of a similarity parameter. These solutions describe either flow through a nozzle or flow past a body, possibly semi-infinite. (BBB)

9155 EXPERIMENTAL DETERMINATION OF CHANNEL DRAG COEFFICIENTS DURING TURBULENT MHD FLOW IN THE PRESENCE OF A TRAVELING MAGNETIC FIELD. **Okhremenko, N. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 119-26(1967). (In Russian).**

The results of experiments on the determination of the drag coefficient of two rectangular metal channels using a plane linear induction pump with side ratios of 14:1 and 15:1 during turbulent mercury flow were described. In the test region, characterized by $Re \ll 8 \times 10^5$, $Ha \ll 28$, $\underline{g} \ll 0.58$, and $St \ll 9.2$, the empirical dependences of the friction coefficient on lateral copper contact strips and without them on the characteristics of the flow, the characteristics of the traveling magnetic field, and the pump parameters. (tr-auth)

9156 FALLING OF LIQUID METAL DROPS IN VISCOUS DIELECTRIC MEDIUM IN THE PRESENCE OF LONGITUDINAL MAGNETIC FIELD. **Zambran, A. P. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 112-18(1967). (In Russian).**

The experimental results of the investigation of the falling of liquid metal drops in a viscous dielectric medium at $Re < 1$ in the presence of a longitudinal field are discussed. It is shown that the Hartmann number M of a given movement regime is the determining criterion for the effect of the magnetic field on the process of inhibition of the falling or, in some conditions, on the deformation of the drop. Saturation of the degree of inhibition of the falling drop appears at $M = 0.5$. (tr-auth)

9157 NUMERICAL CALCULATION OF FLOW OF ELECTRICALLY CONDUCTING FLUIDS BETWEEN ROUGH PLATES IN THE PRESENCE OF TRANSVERSE MAGNETIC FIELDS. **Branover, G. G.; Vitolin'sh, G. A.; Dukure, R. K.; Zolberga, R. P.; Kalis, Kh. E.; Tsinober, A. B. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 105-11(1967). (In Russian).**

The results of the numerical solution of the Navier–Stokes equation were given for flow between parallel rough plates in the presence of a transverse magnetic field. The qualitative comparison of the results of the numerical calculation with the experimental data was made. It was established that the roughness materially affects the coefficient of resistance for laminar flow in the presence of transverse magnetic fields. (tr-auth)

9158 INVESTIGATION OF THE EFFECT OF TRANSVERSE MAGNETIC FIELD ON THE FLOW IN PIPES WITH SUDDEN EXPANSION. **Branover, G. G.; Vasil'ev, A. S.; Gel'fgat, Yu. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 99-104(1967). (In Russian).**

Effects of a transverse magnetic field on the flow of mercury in pipes with sudden expansion were investigated. Data are reported, taking into account distribution of pressure along regions of sudden expansion and the change in the coefficient of resistance. On the basis of the data obtained, the modifications of the Bord theorem were examined for the case of flow in the presence of transverse magnetic field. The results obtained were compared with pertinent calculations. (tr-auth)

9159 STATIONARY JET IN MAGNETIC FIELD. **Eliseev, B. V.; Lobanov, A. D. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 95-8(1967). (In Russian).**

By means of perturbation theory, a solution was obtained for the plane laminar jet flowing in nonviscous medium perpendicular to the external constant magnetic field and electric field. With the decay parameter, the relation of the square of the Hartmann number to the Reynolds number is shown. (tr-auth)

9160 THEORY OF LOW-INTENSITY SHOCK WAVES. **Dementii, O. I.; Lyubarskii, G. Ya. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 74-80(1967). (In Russian).**

The shock waves of low intensity in nonviscous magnetohydrodynamic liquids with finite thermal and electric conductivity were examined. The condition for the existence of ruptures in the profile of Whitham waves were assumed attainable. In spite of this it was shown how the profile of the shock waves are uninterrupted. (tr-auth)

9161 INVARIANT SOLUTIONS OF MHD EQUATIONS. **Korobeinikov, V. P. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 55-8(1967). (In Russian).**

A group analysis was made of a system of equations for the cylindrically symmetric motion of a completely conducting ideal gas. Possibilities for the invariant solution of this system were indicated. Examples of the invariant solutions for two particular forms of the MHD equations were given. (tr-auth)

9162 LORENTZ INVARIANCE, MOMENTUM–ENERGY TENSORS, AND THE MHD PROBLEM. **Edelen, D. G. B. (Purdue Univ., Lafayette, Ind.). Int. J. Eng. Sci., 5: 235-50 (Mar. 1967).**

Along with recent developments in magnetohydrodynamics (MHD) some questions and seeming paradoxes have arisen concerning the momentum–energy tensor and/or the 4-force vector of a fluid element and the 4-current vector. As a 3-fold approach to some of these problems, first, the rigorous consequences of Lorentz invariance for arbitrary tensor fields are obtained. Second, under a precise definition of the momentum–energy tensor, a system of equations for the determination of this tensor in terms of the energy density T^{00} and a system of equations for the determination of the arguments of T^0 were developed. A formulation of MHD problems is then given and shown to be well set. This is accomplished by an extension of the classical existence theorems for linear partial differential equations whereby a collection of state variables can be said to be complete. Lastly, an alternative formulation is presented in which the momentum–energy tensor is derived from the equations of motion and a variational principle. The latter corresponds to the Lagrangian approach to field theory, while the presentation in terms of Lorentz invariance and the generation of the momentum–energy tensor from T^{00} corresponds to the Hamiltonian approach. (BBB)

9163 CLASS OF EXACT MAGNETOHYDRODYNAMIC SOLUTIONS. **O'Brien, Vivian (Johns Hopkins Univ., Silver Spring, Md.); Weinbaum, Sheldon. Phys. Fluids, 10: 2556-65 (Dec. 1967).**

Exact magnetohydrodynamic solutions for incompressible fluids, valid for all values of conductivity and viscosity, are found. These collinear magnetohydrodynamic fields have magnetic surfaces corresponding to stream surfaces. (auth)

9164 FLOWS INDUCED BY NONUNIFORM MAGNETOHYDRODYNAMIC PINCH. **Chow, Chuen-yen; Brunell, Randolph D. (Univ. of Notre Dame, Ind.). Phys. Fluids, 10: 2566-70(Dec. 1967).**

Ring vortices are induced after the passage of an axial current through a stagnant conducting liquid contained between two concentric, corrugated glass tubes with a strong current flowing along the common axis of the tubes. Experiments have been conducted using transparent aqueous solution of copper sulfate suspended with fine aluminum powder for flow visualization. Flow patterns are photographed for the cases that the sinusoidal deformations on the tube walls are either in phase or completely out of phase, and one of the tubes is straight. The result agrees considerably well with that obtained previously from a linearized theory. (auth)

9165 FLOW OVER AN AIRFOIL IN RELATIVISTIC MAGNETOHYDRODYNAMICS. **Tkalich, V. S. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 11-17(1967). (In Russian).**

The problem of relativistic magnetohydrodynamics is studied in three-dimensional form. Symmetry integrals are obtained for the relativistic fluid flow, bearing close resemblance to the Bernoulli and vorticity equations. (TSS)

9166 EFFECT OF FINITE CONDUCTIVITY ON TWO-DIMENSIONAL PLASMA FLOWS IN A COAXIAL CHANNEL. **Brushlinskii, K. V.; Gerlakh, N. I.; Morozov, A. I. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 31-4(1967). (In Russian).**

The effect of finite electric conductivity on flow establishment in a coaxial MHD channel is investigated. The flow is assumed to be unsteady, inviscid, and isothermal, and the magnetic field is in the radial direction. Hall effects are assumed to be absent, and the resulting time-dependent equations are integrated numerically over the ranges $0.03 \leq \beta \leq 5$ and $0.001 \leq \eta \leq 10$, where η is the inverse magnetic Reynolds number and β is the inverse interaction parameter $\beta = p_0/\mu H_0^2$. The results show that the strongest effect of the electric conductivity on the flow is apparent when $\beta \approx 0.05$. Under this condition the radial velocity component in the channel shows steep gradients. (ATD)

9167 EFFECT OF CORE FLOW BOUNDARY CONDITIONS ON BOUNDARY LAYER CHARACTERISTICS IN A LOW-TEMPERATURE MHD PLASMA CHANNEL. **Apollonskii, S. M.; Kos'kin, Yu. P. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 35-42(1967). (In Russian).**

The boundary layer flow in an MHD-channel is analyzed theoretically. Two cases are considered for the core flow: (1) T_∞ in the core is constant whereas the velocity u_∞ varies linearly with axial distances; (2) u_∞ is constant as T_∞ varies linearly with axial distance x. The flow is assumed laminar, steady, compressible, and with small magnetic Reynolds number. Exponential variations in electric conductivity are assumed in the boundary layer for both cases. The velocity and temperature are then expanded in powers of the x coordinate, and the resulting set of infinite ordinary differential equations is solved numerically up to the third order in f and Θ (nondimensional velocity and temperature, respectively). The skin friction and heat transfer coefficients are expressed. (TSS)

9168 THREE-DIMENSIONAL EFFECT IN MHD FLOW IN A CHANNEL WITH SECTIONED ELECTRODES. **Volchek, B. B.; Starominskii, L. R.; Tolmach, I. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 43-9(1967). (In Russian).**

The current density distribution is calculated in an MHD channel with sectioned electrodes. Two cases are considered. One, where the ratio of electrode length to insulator λ is 0.5, and another where $\lambda = 0.9$. The calculations are made for various values of the Hall parameter β and various ratios of channel width to electrode length, using a previously derived expression for the current density. The solution consists of evaluating Weirestrasse sigma functions and tabulating them. The MHD-flow efficiency, power output, potential distribution, and current distribution curves are shown graphically. It is concluded that for $\lambda = 0.9$ a current overflow takes place between adjacent electrodes. This overflow is absent for the case $\lambda = 0.5$. The voltage and power output of the flow are shown to depend on the Hall parameter. (ATD)

9169 VIBRATIONS OF A LIQUID-METAL SPHERE IN A DIELECTRIC MEDIUM IN THE PRESENCE OF A CONSTANT MAGNETIC FIELD. **Zambran, A. P.; Tovmenko, S. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 72-4(1967). (In Russian).**

An experimental verification was carried out of the theoretically derived expression for the period of vibration of a liquid-metal sphere suspended in a dielectric medium in the presence of a constant magnetic field as proposed by Gailitis (Magn. Gidrodin., No. 2, 79(1966). (TSS)

9170 EXPERIMENTAL INVESTIGATION OF MERCURY FLOW UNDER THE INFLUENCE OF A TRAVELING MAGNETIC FIELD. **Zander, Yu. K.; Lielpeter, Ya. Ya. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 93-7(1967). (In Russian).**

An experimental study of the effect of a traveling magnetic field on the turbulent flow of metallic mercury was carried out. The study was initiated to extend the present theory of magnetohydrodynamic machines. It was found that the traveling magnetic field has a negligible effect on the hydrodynamic losses observed for turbulent mercury flow. (TSS)

9171 ROTATION OF CONDUCTING LIQUID UNDER AN UNMOVING DISK IN THE PRESENCE OF MAGNETIC FIELD. **Glazov, O. A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 75-80(1967). (In Russian).**

Analysis is made of the boundary layer in a rotating conducting liquid over a dielectric disk with infinite radius. The magnetic field B_0 is perpendicular to the plane of the disk, and the fluid motion is assumed to occur between two porous coaxial cylindrical electrodes with axes parallel to B_0. The governing three-dimensional boundary-layer equations are solved by using a two-parameter integral method. (TSS)

9172 MOTION OF AN ELECTRICALLY CONDUCTING FLUID GENERATED BY A SLOWLY ROTATING DISK IN A CASING IN THE PRESENCE OF AN AXIAL MAGNETIC FIELD. **Gorbachev, L. P.; Grizor'ev, M. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 81-4(1967). (In Russian).**

The steady flow of a conducting viscous fluid, generated by a thin, slowly rotating dielectric disk, is analyzed theoretically. The disk rotates in a cylindrical casing of radius R, at a distance d from the bottom, in the presence of an axial magnetic field H_0. It is assumed that the flow fulfills the conditions $v_z d/\nu \ll 1$, $(\sigma^2\mu_a^2 H_0^2 d^2/\rho) \ll 1$, where v_z is the axial component of the velocity. The governing flow and magnetic induction equations are reduced to the following set of differential equations: $(M^2/d^2)(\partial^2 v_\varphi/\partial z^2) = \Delta^2 v_\varphi$, $[(\partial^2/\partial z^2) + r(\partial/\partial r)(1/r)(\partial/\partial r)]^2\psi - [(M^2/d^2)(\partial^2\psi/\partial z^2)] = -2[(v_\varphi/\nu)(\partial v_\varphi/\partial z)]$, where M is the Hartmann number and ψ is the stream function. A closed form solution is obtained for the limiting case where $d/R \to 0$. The more general case leads to a series solution in v_φ and H_φ in terms of Bessel functions of the first order and first kind. (ATD)

9173 POSSIBILITY OF BOUNDARY LAYER STABILITY INCREASING BY MEANS OF CROSSED ELECTRIC AND MAGNETIC FIELDS. **Tsinober, A. B.; Shtern, A. G. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 152-7(1967). (In Russian).**

The possibility of preventing transition to turbulent flow is investigated for flat plate laminar flows of conducting fluids. A body force is generated by a system of alternating electrodes and magnetic poles placed in the form of strips along the plate. This body force has the magnitude $F = 2.87 j_0 B_0 e^{(-\pi/2a)y}$ where a is the width of the electrode. For flows with zero-pressure gradients, the solution of the incompressible boundary-layer equations shows that the following two criteria are needed to prevent transition $1.16(a^2 j_0 B_0/u_0\rho\nu) = 1$ and $2u_0 a/\pi\nu \leq 4.10^4$. (ATD)

9174 PECULIARITIES OF TURBULENCE DAMPING IN PIPES BY MEANS OF LONGITUDINAL AND TRANSVERSAL MAGNETIC FIELDS. **Branover, G. G. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 156-7(1967). (In Russian).**

The author reviews his experimental work in suppression of turbulence in rectangular channels in the presence of transverse and longitudinal magnetic fields. For all cases under study with transverse magnetic fields, the critical Reynolds number is shown to be related to the Hartmann number by the equation $\mathrm{Re} = k\,\mathrm{Ha}$, where $130 \leq k \leq 215$. The results with longitudinal fields are inconclusive. It is shown, however, that all three velocity fluctuation components, as well as the derivative $\partial u'/\partial x$, are suppressed by longitudinal magnetic fields. (ATD)

9175 THREE-DIMENSIONAL SELF-SIMILAR BOUNDARY LAYERS IN A TRANSVERSE MAGNETIC FIELD. Karyakin, Yu. E. (Leningrad Polytechnic Inst.). Zh. Tekh. Fiz., 37: 1617-22(Sept. 1967). (In Russian).

A certain class of solutions (called "self-similar") to the magnetohydrodynamic equations is discussed for the steady laminar flow of an incompressible conducting viscous fluid in the presence of an infinite plane boundary and a (not necessarily uniform) magnetic field perpendicular to the boundary. The self-similar solutions are those for which the rectangular components u, v, and w of the velocity are given by $u = U(x,y)F(\gamma)$, $v = V(x,y)G(\gamma)$, $w = 0$ with $\gamma = zg(x,y)$, where x, y, z are rectangular Cartesian coordinates, the boundary is the plane $z = 0$, and the functions F and G vanish for $\gamma = 0$ and approach unity when γ increases without limit. Values of the functions $U(x,y)$, and $H(x,y)$ (giving the strength of the magnetic field) for which such solutions exist are found, and 14 families of such functions are listed. The solutions for which U is proportional to x^n, V to x^{1-n}, and H to $x^{(n-1)/2}$ are discussed. (ATD)

9176 QUASI-ALIGNED FIELD FLUXES IN MAGNETO-FLUIDDYNAMICS. Thibault, R. (Univ. of Rouen, France). Rev. Roum. Sci. Tech., Ser. Mecan. Appl., 12: 43-54(1967). (In French).

Steady movements of a nonviscous compressible fluid are studied. These movements are two-dimensional, each physical value being a function of two coordinates, but not plane; further the magnetic field and the velocity are assumed to have projections on the reference plane. When the fluid is a perfect conductor, one may extend some valuable methods for plane movements by substitution of the Mach number. All transitions between sub-Alfvénic and super-Alfvénic movements become impossible. Where movements have the Alfvén number close to one, they may be considered as incompressible. There are finite values of movement parameters for which the substituted Mach number is infinite, and particular attention is given to these cases. If the fluid is not a perfect conductor, Dragos' method for plane movements can be extended, and flux in space may be considered as homologous to plane flux, unless a supersonic flux has a subsonic projection on the reference plane. For homologous fluxes the pressure coefficient varies with the angle of incidence. (BBB)

9177 CURRENT DISTRIBUTION IN A FLAT MAGNETOHYDRODYNAMIC CHANNEL DURING THE MOTION OF A CONDUCTIVE MEDIUM IN A STRONG MAGNETIC FIELD. Emets, Yu. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 3-11(May-June 1967). (In Russian).

The determination of current distribution in a flat magnetohydrodynamic channel is reduced to the solution of the boundary value problem in a special class of periodic functions. To this end, use is made of the theory of boundary value problems in the class of automorphic functions. (ATD)

9178 FREE CONVECTION OF A CONDUCTING FLUID IN CONNECTED VERTICAL CHANNELS. Gershuni, G. Z.; Zhukhovitskii, E. M. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 31-5(May-June 1967). (In Russian).

Free convection in two connected vertical plane channels is analyzed in the presence of a transverse magnetic field. The channels are of width 2h and are a distance 2d apart between their centerlines. The analysis is carried out for a steady state condition where all inertia terms are neglected. The governing equations are: the momentum equation with the buoyancy term, the magnetic induction equation, and the energy equation. The velocity, temperature, and magnetic field distributions are obtained in closed form and an expression is developed for the convection. The stability of the resulting equilibrium case is investigated under conditions of heating from below. Expressions are obtained which describe the spectra of critical Rayleigh numbers R. It is shown that for the "even" solution (velocity and temperature-even functions of the initial coordinate, magnetic field-odd function) the critical value of R depends on the Hartmann number, as well as the parameter $\lambda|x_1|$. For the "odd" solution (the inverse of the even solution) the critical Rayleigh number depends only on the Hartmann number. (ATD)

9179 SPECIAL FEATURES OF THE VORTEX STABILIZATION OF A CONDUCTING GAS IN A RADIAL ELECTRIC FIELD. Dautov, G. Yu.; Mustafin, G. M. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 107-11(May-June 1967). (In Russian).

Taylor et al., have previously studied the instability of the interface between a heavy conductive fluid and a lighter nonconductive fluid placed above it in a high-intensity electric field of a flat electrode. They have also shown that the shorting of the conductive fluid against the electrode is due to the instability of the interface. Their mathematical approach and the results contained in their work are used in the present article to calculate the vortex stabilization of a plasma filament in a radial electric field. Formulas are derived for the calculation of the minimum velocity of rotation of the medium required to stabilize the filament and of the critical potential at which the filament surface becomes unstable (hydrodynamic instability which is not related to the electric field is not investigated or taken into account). It is shown that, under specific conditions, this critical potential is considerably lower than the potential of an avalanche breakdown and that the shorting mechanism of the plasma with the electrode may play an important part under vortex stabilization conditions. (ATD)

9180 OSCILLATORY CHARACTERISTICS OF UNSTEADY MHD CHANNEL FLOWS UNDER HEAVISIDE-TYPE APPLIED MAGNETIC FIELDS. Eraslan, Arsev H. (Univ. of Tennessee, Tullahoma). J. Appl. Mech., 34: 854-9(Dec. 1967).

The unsteady, fully developed MHD channel flow of a viscous, electrically conducting fluid is investigated under Heaviside-type applied magnetic fields. The fluid is assumed to be of constant properties and the Hall effect is neglected. The exact solutions, for the velocity and the induced magnetic fields, are obtained by Laplace and finite Fourier transforms for the ideally conducting wall conditions. It is shown that, during the transition from hydrodynamic to magnetohydrodynamic conditions, the flow undergoes strong oscillations, depending on the characteristic parameters, magnetic Prandtl number, and the Hartmann number, in contrast to the nonoscillatory transition from magnetohydrodynamic to hydrodynamic conditions. (auth)

9181 EXISTENCE THEOREM FOR THE FLOW AROUND A PLANE PLATE. Sanchez-Palencia, Enrique (Faculte des Sciences, Paris. Ciudad Univ., Madrid). Compt. Rend., Ser. A and B, 265: 354-7(Sept. 18, 1967). (In French).

The question of determining the stationary flow of an incompressible viscous electrically conducting fluid around a plane plate with zero angle of incidence is considered. The existence of a weak solution of this problem is shown. (tr-auth)

9182 POTENTIAL AND CURRENT DISTRIBUTION IN MPD ARCS. Coleman, R. L.; Hassan, H. A.; Garcia, B. H. Jr. (North Carolina State Univ., Raleigh). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 2228-31(Dec. 1967).

Based on calculations of two basically similar devices, in which the anode and cathode geometries were the same but the distance between the cathode tip and exit plane of the anode L were different, it is shown that the electrode geometry has a pronounced effect on the current and potential distribution in MPD arcs. The plume contribution to the thrust increases with a decrease in L; however, for the configurations considered, the acceleration is generally restricted to a region of about 1-anode-diam downstream of the cathode tip. The calculations also show that the Hall current densities are, in general, higher than radial current densities throughout the engine and exhaust plume, and are comparable to the axial current densities within the electrode region. (auth)

9183 HALL EFFECT IN FLIGHT MAGNETOGASDYNAMICS. Porter, Robert W.; Cambel, Ali Bulent (Northwestern Univ., Evanston, Ill.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 2208-13(Dec. 1967).

The influence of the Hall effect on magnetogasdynamic flow around the nose of a blunt body is considered. In the present analysis local similarity is applied to the stagnation region of the attached shock layer generated in the hypersonic flow about a blunt body containing a magnetic dipole source. Both electrically conducting and insulated bodies are considered. The Hall effect causes the fluid to acquire a component of current at right angles to the electric field relative to the fluid. In the case of axisymmetric flow, currents arise in the meridian planes as well as reduced currents in the azimuthal direction. The former interact with the magnetic field and produce an azimuthal Lorentz body force that induces flow in the azimuthal direction and produces a reactive torque on the magnetic source. In general the magnetogasdynamic effect is to increase the shock standoff distance and the total drag experienced by the body. However, when Hall effects are considered, these changes are less pronounced. Further, the conducting body is found to have a greater shock standoff, drag, and rolling-moment coefficient than the insulated body. (auth)

9184 SOURCE-FLOW EXPANSION OF A PARTIALLY IONIZED GAS INTO A VACUUM. Chou, Y. S.; Talbot, L. (Univ. of California, Berkeley). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 2166-72(Dec. 1967).

The purpose of the investigation was to provide some theoretical results for use in predicting the flow conditions which could be expected in freejet plasma expansions. The model investigated is a one-dimensional spherically symmetric, supersonic source flow of partially ionized argon, the assumption being that this model represents a reasonably good approximation for the centerline flow conditions of a freejet. The analysis utilizes kinetic theory equations of change for the three species (ions, electrons, and neutrals) and a relaxation-type collision model. An ellipsoidal Maxwellian distribution function for each of the species is postulated, and using this distribution function equations for the macroscopic flow variables are derived. The reactions considered are two-body ionization and collisional-radiative recombination, with rate constants being those computed by Bates and co-workers. Both the optically thick and optically thin cases are investigated. The equations are integrated numerically for the case of argon. Two types of source flows are investigated: (1) a simple supersonic source flow, with the initial supersonic state assumed to be an equilibrium one; and (2) a nozzle expansion from an equilibrium stagnation state to slightly supersonic conditions, followed by a source flow. In the second case, both equilibrium and nonequilibrium nozzle flows are considered. (auth)

9185 COMPRESSIBLE LAMINAR MHD FLOW INSIDE A FLAT DUCT WITH HEAT TRANSFER. Hwang, U. P.; Fan, L. T.; Hwang, C. L. (Kansas State Univ., Manhattan). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 2113-21(Dec. 1967).

An analysis is presented of two-dimensional, steady-state, laminar, compressible flow of an electrical conducting fluid inside a flat duct with a transversely applied magnetic field. The boundary-layer equations for the compressible MHD flow are solved by a new approach based on Morris and Smith's work on non-MHD flow. The compressible boundary-layer equations including the continuity, momentum, and energy equations are reduced to ordinary differential equations which are solved simultaneously by numerical integration. No restrictions are imposed on the Prandtl number. A very general form of viscosity variation with respect to temperature is used in the development of the general equations. A sample problem with the constant wall temperature, the Mach number of 0.8, and the Prandtl number of 0.01 is solved numerically. Investigations include the growth of the dynamic boundary and thermal boundary layers, the development of the velocity and temperature profiles, and the skin friction and heat transfer. The results show that the skin friction and heat transfer are increased with the increase of magnetic field strength. To obtain an estimate of the validity of the method, it is applied to the solution of incompressible flow problems for which some reliable solutions are available. (auth)

9186 INVESTIGATION OF POTENTIAL PROBLEMS WITH TENSORIAL CONDUCTIVITY OF THE SEMICONDUCTORS AND PLASMAS IN A TRANSVERSE MAGNETIC FIELD. Haeusler, Jochen. Stuttgart, Technische Hochschule, 1967. 112p. (In German).

Thesis.

The following exact solutions were obtained: potential distribution and resistance changes of ellipsoidal probes in terms of elementary functions, magnetic field dependence of resistance matrix elements (usable for semiconductor Hall generators, field plates, and MHD generators), and evaluation of maximum efficiency of a specially dimensioned circulator. Further studies for the Hall generator included estimation of errors. With increasing magnetic field the emissions point for the current path to the electrode is moved to a corner, so that the average is lowered. This decrease in the average is more important than the increase of the current path in the increase of resistance, although the latter is frequently used to explain the increase. Conformal images are recommended as an aid in the investigation of plane problems, since they are more appropriate than numerical techniques for optimization problems and for the analysis of fundamental phenomena of construction elements. (BBB)

9187 EFFECTS OF THE INDUCED MAGNETIC FIELD ON THE INVISCID MAGNETOHYDRODYNAMIC CHANNEL FLOW. Denno, Khalil Ibrahim. Ames, Iowa, Iowa State Univ. of Science and Tech., 1967. 128p.

Thesis.

The effects of a nonuniform magnetic field on a magnetohydrodynamic channel flow between two parallel plates of infinite extent were studied. The fluid flow was assumed to be electrically conducting, thermally nonconducting, inviscid, and incompressible. The ultimate goal in this study was to explore the improvement in prevention of contact of hot conducting fluid with the channel walls. This was done by including the effect of the induced magnetic field such that the magnetic Reynolds number R_m is smaller than unity but not zero. Expressions for distortions in the magnetic field and the flow field were obtained using the perturbation method, in which both were represented in a double power series in the magnetic Reynolds number R_m and the magnetic interaction parameter I. The expansions of the power series were carried to the first order in the product of I and R_m. Partial differential equations resulting from the perturbation method of the induced magnetic field and distortion in the flow field are given. Solutions at the channel walls were obtained analytically using the Fourier transforms. The static and the magnetic pressure gradients along the lower channel wall (i.e., at $y = 0$) were evaluated numerically using a digital computer. They showed a clear influence of the induced magnetic field in improving the separation of the hot conducting plasma from the internal surfaces of channels. The results revealed the fact that as the channel height increased, the magnetic field would have more freedom in deflecting the flow and slowing it down. Also, it was concluded that when R_m is of the order of 0.10 and greater, it will have an obvious effect in improving fluid separation from the channel wall. (Diss. Abstr.)

Geophysics

Refer also to abstracts 8974, 9130, 9153, and 9315.

9188 (TID-24203, pp 37-43) GEOPHYSICAL RESEARCH. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Experiments were made to determine the aerosol content of air from spectral analysis of laser echoes. Measurements were made of the density and temperature of electrons in a low-density reflex discharge by scattering of continuous-wave Ar^+ laser light. (M.O.W.)

9189 PRECIPITATED ELECTRONS AS A CAUSE OF THE IRREGULAR BEHAVIOUR OF THE F2 REGION. Torr, M. R.; Torr, D. G. (CSIR, Johannesburg). Nature (London), 217: 45(Jan. 6, 1968).

It has been established that electrons precipitated from the outer radiation belt produce ionospheric disturbances. Most of these disturbances have been found to involve decreases in f_0F2, suggesting that the fluctuations in precipitated electron flux will produce a spread in f_0F2 values about the hourly means. The authors have compared latitudinal and longitudinal variations in precipitated electron flux with similar variations in the rms deviation of f_0F2. For the longitudinal analysis a number of ionosphere stations lying along $L = 4$ in the southern hemisphere were selected, and for the latitudinal analysis five southern hemisphere stations lying over the range 140 to 170°E and extending from $L = 1.5$ to 4.0. The latter lie well outside the S. Atlantic geomagnetic anomaly. The rms deviation of f_0F2 was calculated for each hour for the selected stations, and correlations with electron precipitation established. It was found that data for midnight showed a far more pronounced longitudinal variation than data for midday. It has been suggested that atmospheric winds result in ionosphere drifts having a vertical component which is usually downward during the day and upward during the night. It is therefore possible that at night the ionization produced by the incoming electrons may be blown upwards into a low loss rate region, magnifying the effect. (UK)

9190 RADIO EMISSION FROM GEOMAGNETICALLY TRAPPED PARTICLES. Harvey, C. C. (Cambridge Univ., Eng.). Nature (London), 217: 50-1(Jan. 6, 1968).

In many experiments to measure the radio noise intensity in the topside ionosphere an intense noise "band" has been observed in the frequency range between the plasma frequency and the upper hybrid resonance frequency. Various explanations have been advanced for this; data received by the Ariel 2 satellite suggest that the energy for this noise comes from the particles trapped in the inner Van Allen radiation belt. In the studies reported in this communication the noise bands were found to be of three principal types: (a) noise between the plasma frequency and the upper hybrid resonance frequency, (b) anomalously intense noise below the local plasma frequency and above the extraordinary wave cutoff frequency, and (c) low-frequency noise with no definite cutoff frequency. The author examined in detail the interference-free passes near to apogee. The intensity of the noise band of type (a) was a maximum near the value $L = 1.35$, which is the position of the maximum energetic particle intensity in the inner Van Allen belt. There was also evidence that the source of noise of type (b) is also the particle radiation of the inner Van Allen belt. (UK)

9191 A QUICK METHOD OF USING TOPSIDE IONOGRAMS FOR IONOSPHERIC INVESTIGATIONS. Eccles, D. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1337-44(Nov. 1967).

A simple and rapid technique is described for deriving information, from large numbers of topside ionograms, about the electron concentration at heights below the sounder satellite. The technique is especially valuable for determining latitude variations of electron concentration in the upper F region and, hence, for studies of phenomena such as the equatorial anomaly. The amount of work involved in determining the latitude variation of electron concentration near 500 km by means of the new technique is several orders of magnitude less than that required by conventional N(h) reduction methods. (auth) (UK)

9192 TOPSIDE SOUNDER STUDIES OF CORPUSCULAR RADIATION EFFECTS ON THE IONOSPHERE DURING QUIET AND DISTURBED CONDITIONS. King, J. W.; Smith, P. A.; Reed, K. C.; Seabrook, C. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1327-36(Nov. 1967).

Studies of electron scale heights obtained from topside ionograms lead to the conclusion that energetic particles do not usually affect the ionospheric plasma temperature at heights of 400 or 500 km. During magnetic disturbances, however, the electron scale heights in the region of the South Atlantic magnetic anomaly, but not at other longitudes, appear to be abnormal. It is suggested that some of the localized ionization abnormalities occurring in the South Atlantic area at certain L values may be caused by particles dumped there, and evidence of a possible association between spread-F ionization and energetic particles is presented. Unfortunately no direct proof exists of the reality of the particle effects discussed. (auth) (UK)

9193 ESTIMATES OF IONOSPHERIC COMPOSITION AND TEMPERATURE DERIVED FROM TOPSIDE SOUNDER ELECTRON SCALE HEIGHT DATA. Smith, P. A.; Kaiser, B. A. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1345-53(Nov. 1967).

Electron and ion temperatures and mean ion mass at heights of 500, 700, and 1000 km were calculated for different latitudes in the South Atlantic area by using, with minimum additional information, scale height values derived from distributions of electron concentration obtained by means of the Alouette I satellite. Both the electron and ion daytime temperatures increase markedly with latitude, by about 800°K over 40° of latitude, but probably less rapidly at night. The upper limit calculated for the increase of plasma temperature with height is ~1.2°K/km at lower latitudes and ~2.8°K/km at higher latitudes. By day the decrease of mean ion mass with height is less pronounced at higher than at lower latitudes; the transition level from oxygen ions to lighter ions lies above 1000 km at higher latitudes, but decreases to 600 km at lower latitudes. At night the scale height results are consistent with a situation in which the transition level rises with latitude but occurs at a lower height than by day. In order to obtain, from the nighttime scale height data, values of mean ion mass which agree with some directly measured values, it seems necessary to postulate the existence of a height gradient of plasma temperature at night. (auth) (UK)

9194 BEHAVIOUR OF THE TOPSIDE IONOSPHERE DURING STORM CONDITIONS. King, J. W.; Reed, K. C.; Olatunji, E. O.; Legg, A. J. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1355-63(Nov. 1967).

The behavior of the topside ionosphere during five different storms is discussed; certain features of the observed behavior appear so consistently that it seems possible to make several generalizations about the storm behavior of the topside ionosphere. The storm effects are much more pronounced at the lower heights where the electron concentration varies by up to a factor of four. The evidence suggests that the effects are due more to a vertical movement of the layer than to a primary change in N_mF2. The storm effects vary markedly with latitude, being more "positive" at lower latitudes; "negative" storms occur at higher latitudes. Evidence is also given which indicates that sometimes the storm effects are positive shortly after the magnetic SC, but become negative later. (auth) (UK)

9195 OBSERVATIONS OF THE TOPSIDE IONOSPHERE DURING THREE SOLAR ECLIPSES. King, J. W.; Legg, A. J.; Reed, K. C. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1365-71(Nov. 1967).

Observations of the topside of the ionosphere made during three eclipses are presented. In two of them, during which the magnetic conditions were quiet, the electron concentration at heights above 350 km decreased by a factor of two. This effect in the topside ionosphere is shown to be due predominantly to a downward movement of the layer rather than to any significant change in the peak electron concentration. During the recovery phase, which appears to last about 3 hr, the layer rises again. Data from the third eclipse, which coincided with a magnetic storm, show typical storm-time effects great enough to obscure the effects of the eclipse. (auth) (UK)

9196 OBSERVATIONS OF SPREAD IONIZATION IN THE TOPSIDE OF THE IONOSPHERE. King, J. W.; Legg, A. J.; Smith, P. A. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1373-81(Nov. 1967).

The occurrence of two distinct types of spread-F ionization observed by means of the Alouette I satellite is discussed. The boundary at the low-latitude edge of the zone of conventional high-latitude spread-F is shown to be very sharp and of large vertical extent, occurring substantially closer to the equator at night than by day. It has been suggested that, on some occasions, the conventional spread-F echoes observed on both topside and bottomside ionograms may be the result of a delayed resonance effect. Spread-F traces which appear to be produced by localized sheets or patches of ionization occur more frequently at night, and also during magnetically disturbed conditions. (auth) (UK)

9197 THE RECEPTION OF GROUND-BASED LORAN TRANSMISSIONS BY THE FIXED-FREQUENCY TOPSIDE SOUNDER SATELLITE. Legg, A. J.; Newman, W. S. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1383-6(Nov. 1967).

Transmissions from ground-based Loran stations have frequently been detected by the 2-MHz receiver on the Explorer 20 satellite; the form of the resultant interference permits the identification of individual Loran transmitters. A statistical study of the occurrence of the interference on passes recorded at Winkfield, in the United Kingdom, suggests that it is due to an E—W trough of low critical frequency at latitudes between about 55°N and 65°N at western European longitudes; this trough may be associated with the trough of low electron density observed over Canada. (auth) (UK)

9198 OBSERVATIONS OF PROTON GYRO-EFFECTS IN THE TOPSIDE IONOSPHERE. King, J. W.; Preece, D. M. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1387-90(Nov. 1967).

The electron-resonance spikes on the Alouette I ionograms often exhibit distinctive spurs, and these are suggested to be a proton gyro-effect of some kind. The absolute values, and also the latitude variation, of the total magnetic intensity derived from the spurs, on the assumption that they are a proton gyro-resonance effect, agree with the actual values of magnetic intensity to about one percent, which is better than the estimated accuracy of measurement. The occurrence of the spurs is shown to be closely associated with the satellite orientation. (auth) (UK)

9199 INTEGRATED ELECTRON CONTENT IN THE EQUATORIAL IONOSPHERE. King, J. W.; Olatunji, E. O.; Eccles, D.; Newman, W. S. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1391-6(Nov. 1967).

It is shown that an equatorial anomaly exists in the electron content of the topside ionosphere such that the electron content during the early afternoon is greater at latitudes north and south of the magnetic equator than at the equator itself. The diurnal variations of the topside subpeak and total electron contents above Singapore, where the magnetic dip is 17°S, indicate that the increase in total electron content which occurs between noon and 16.00 L.M.T. is due entirely to an increase in the topside content during that period. (auth) (UK)

9200 DIURNAL VARIATIONS OF THE ELECTRON CONCENTRATION IN THE TOPSIDE IONOSPHERE AT LOW AND MIDDLE LATITUDES. Legg, A. J.; King, J. W.; Preece, D. M. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1397-1401(Nov. 1967).

The diurnal variations are presented for two different seasons. The data show that at middle latitudes a secondary night-time maximum of electron concentration occurs at heights between 400 and 1000 km. The midlatitude daytime electron concentration at 800 and 1000 km is greater in local summer than at equinox. (auth) (UK)

9201 S_q CURRENTS IN THE AMERICAN EQUATORIAL ZONE DURING THE IGY. I. SEASONAL EFFECTS. Hutton, Rosemary (Ahmadu Bello Univ., Zaria, Nigeria). J. Atmos. Terrest. Phys., 29: 1411-27(Nov. 1967).

IGY data from eight South American stations covering a latitudinal range of approximately 35° were used in a new study of the equatorial electrojet. It was found that the space gradients of

S_q(H) were appreciable at latitudes just beyond those normally regarded as constituting the electrojet zone. This suggests that any simple procedure for separating the total magnetic field into normal and electrojet components will be unreliable. There is considerable disagreement between the observed results and those expected on the basis of the uniform band model of the electrojet, especially with respect to the vertical component. It is suggested that this discrepancy may be due to the complex form of the S_q vortices, the N vortex penetrating well into the S hemisphere in the morning hours of the June solstice and the S vortex penetrating above the magnetic equator in the early morning hours of the December solstice. Both vortices tend to be drawn into the region of enhanced conductivity at the magnetic equator during the Equinoxes, but at other times of the year one vortex appears to provide the predominant contribution to the currents in the magnetic equatorial belt. The importance of observing all three magnetic components simultaneously at a wide range of stations in the equatorial region is stressed. (auth) (UK)

9202 S_q CURRENTS IN THE AMERICAN EQUATORIAL ZONE DURING THE IGY. II. DAY-TO-DAY VARIABILITY. Hutton, Rosemary (Ahmadu Bello Univ., Zaria, Nigeria). J. Atmos. Terrest. Phys., 29: 1429-42(Nov. 1967).

Using the same data as that used in Part I, a study was made of the features of the electrojet currents on a number of individual Quiet Days during the IGY in South America. Day to day variability in the strength and form of the electrojet is observed. Due to the complex nature of the latitudinal variation in current strength, it seems unlikely that calculations of electrojet parameters such as width and position can be determined with any accuracy on the basis of a simple model electrojet. Since the electrojet region is at times under the influence of only one of the current vortices and at other times both vortices contribute to the electrojet current, it is suggested that for some equatorial geophysical studies it may be necessary to classify the days, or even parts of days, into N—northern type, S—southern type and E—equatorial type, according as the overhead currents for a particular station belong to one or both vortices. For this reason, and also as a result of the complexity in the form of the electrojet currents, correlation of electrojet parameters with those at other latitudes may be very difficult to interpret correctly. (auth) (UK)

9203 VLF PROPAGATION ACROSS THE GEOMAGNETIC ANOMALY DURING S.I.D.s. Kaufmann, Pierre; Schaal, Ricardo E.; Lopes, W.; Arakaki, L. (Mackenzie Univ., Sao Paulo, Brazil). J. Atmos. Terrest. Phys., 29: 1443-51(Nov. 1967).

A number of S.I.D.s (sudden ionospheric disturbances) was selected and analyzed, in order to find some compatibility with the general form of the theory of waveguide mode propagation in an Earth–ionosphere spherical waveguide having an upper boundary characterized by a conductivity parameter derived from an exponential model. The vlf transmissions were received at a site located near the center of the South Atlantic Geomagnetic Anomaly, all of them crossing the region of the equatorial electrojet. The results show that the general formulation may be used if the daytime upper boundary is below 65 km. On the other hand the peculiar physical conditions found in the upper atmosphere along such paths possibly have an important influence on its shape and on the considered waveguide configuration, and they must be considered for obtaining a better understanding of the S.I.D. effects. Further experiments are suggested, emphasizing the need of a more accurate knowledge of the dependence of the ionospheric parameter L on frequency. (auth) (UK)

9204 ON OBSERVATIONS AND THEORIES OF THE VLF EMISSIONS. Kimura, Iwane (Kyoto Univ.). Planet. Space Sci., 15: 1427-62(Sept. 1967).

Recent observations made on the ground and by satellites have revealed a variety of vlf emissions. The observational results are reviewed. The intensity, and diurnal and seasonal variations are summarized, paying particular attention to chorus and hiss, and characteristics of these two kinds of emissions are compared with other geomagnetic phenomena. Apparent differences are found between the two kinds of emissions, suggesting that the generating mechanisms are very different. Characteristics of artificially stimulated emissions (ASE), one of which is offset phenomenon, and those of quasiperiodic emissions, are described in detail. Theoretical interpretations for the mechanism of vlf emissions are also surveyed. In general, there are three main theoretical categories: noncoherent radiations, coherent beam wave interactions, and radio emissions from a plasma wave. The first are radiations from drifting single particles, the intensity, however, being insufficient in comparison with that of the observed emission. The second is concerned with instabilities for whistler wave mode, which may arise at the gyroresonance condition in a plasma beam system, and may be the most likely mechanisms for the generation of intense vlf emissions. The third consists of wide band radio emissions excited by hydromagnetic shock waves, which may be a mechanism of hiss. The frequency versus time spectra of each kind of vlf emission are discussed, this being the crucial property for classification of the emissions. It is concluded that the theories of beam wave interaction are not yet complete to the point of interpretation for every fine spectral structure. Theoretical interpretation for the offset phenomenon of ASE is proposed, which is based on cyclotron instability by an electron beam. The quasiperiodic emissions may be understood as being produced by a sequence of offset effects. Energies of the beam particles (e.g. electrons or protons) required for gyroresonance, and the frequency of generated emissions are calculated for geocentric distances, under appropriate assumptions. The energies of the particles needed for the generation of chorus and hiss are then evaluated. (auth) (UK)

9205 EFFECT OF THE STARFISH HIGH-ALTITUDE NUCLEAR EXPLOSION ON THE F2 REGION. Whitten, R. C. (Stanford Research Inst., Menlo Park, Calif.); Dalgarno, A. Planet. Space Sci., 15: 1419-26(Sept. 1967).

The effect of a high-altitude nuclear explosion, such as the Starfish burst of July 9, 1962, on the electron loss rate in the F2 region is discussed. A method for computing the electron density profile at various times after detonation is developed, and the results are compared with available observations. The electron loss rate implied by the observations is larger than that of the undisturbed atmosphere, and it is suggested that a substantial part of the enhancement can be attributed to the production of vibrationally excited N_2. (auth) (UK)

9206 OBSERVATIONS OF THE SEPTEMBER 2, 1966 PCA EVENT. MIDDAY RECOVERY IN ABSORPTION. Brown, R. R. (Univ. of California, Berkeley); Parthasarathy, R. Planet. Space Sci., 15: 1667-75(Nov. 1967).

Balloon and riometer observations of the end-phase of a PCA midday recovery indicated that the increase in absorption was accompanied by corresponding changes in particle flux, with the high-energy portion of the spectrum increasing before the lower energy end. (auth) (UK)

9207 SOLAR DAILY DISTURBANCE VARIATIONS IN THE LOWER IONOSPHERE. Brown, G. M.; Wynne, R. (University Coll. of Wales, Aberystwyth). Planet. Space Sci., 15: 1677-86(Nov. 1967).

The solar daily disturbance variations (SD) in the critical frequency and minimum equivalent height of both the E and F1 regions were determined from expanded-scale ionograms obtained over the period 1961–64. Comparison of the variations with the simultaneous SD component in the horizontal magnetic field shows that, in all cases, the ionospheric and magnetic changes are related in the same way as previously found for the S_q variations on magnetically quiet days. The small SD changes in the ionospheric parameters, like the corresponding S_q changes, appear due to the distorting influence on the electron density profile of vertical electrodynamic transport caused by current flow orthogonal to the field. The results provide strong evidence that the current system which causes the diurnally varying component of magnetic disturbance at a middle latitude flows in the ionosphere, and that its influence extends over a considerable height range from the E to the F1 layers. (auth) (UK)

9208 D-REGION ELECTRON-DENSITY DISTRIBUTIONS FROM PROPAGATION DATA. Bain, W. C.; May, B. R. (Radio and Space Research Station, Slough, Eng.). Proc. Inst. Elect. Eng. (London), 114: 1593-7(Nov. 1967).

By using a fullwave computer program Deeks was able to find an electron-density distribution in the D region which would account for certain vlf and lf propagation results. In the present paper more extensive experimental results are employed for this purpose, in particular, ground-interference patterns on 16 and 21 kHz. Stationary-phase techniques are developed to enable such patterns to be calculated from an assumed distribution. It is found that, to get the best fit, Deeks's distribution has to be modified appreciably; the required change can be described roughly as reducing its height by about 6km. (auth) (UK)

9209 SIMULTANEOUS ANALYSIS OF WHISTLERS AT THREE ADJACENT RECORDING STATIONS AT HIGH MAGNETIC LATITUDES IN SWEDEN. Norinder, Harald; Knudsen, Edgar. Ark. Geofys., 5: 107-13(1967).

Unusual whistlers and their propagation conditions below the ionospheric layers were investigated by using 3 adjacent stations. During a 2-month recording period, about 700 individual unusual whistlers were analyzed and classified in 3 different groups with reference to their variational features. Some typical recordings obtained from the stations are illustrated, and a general survey as to the extent to which the different variational groups occur, are given in a table. It was found that between Jönköping and Uppsala whistlers occurred that were characterized by considerable differences. Comparison of occurrence of whistlers during the evening periods in Uppsala and Lund showed a preponderance of whistlers in Lund, the whistler activity being 3 times greater in Lund than in Uppsala. It was noted that the whistler activity observed in Lund included mainly whistlers of the short type (one hop) during the summer season. (BBB)

9210 ABSORPTION OF SHORT WAVES IN THE IONOSPHERE. Schwentek, Heinrich (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Nachrichtentech. Z., 20: 129-32 (Mar. 1967). (In German).

Relatively regular daily absorption patterns have been shown to be related to a power of the cosine of the Sun's angular position; data for the period 1961–65 are shown to correlate well with this function. Subsolar absorption is shown to depend upon the sunspot cycle; an equation is determined which is a function of both the mean annual relative number of sunspots, the noon position of the Sun, and an addition term for the winter anomaly in absorption. Mean values for the sunspot number and the winter anomaly term are illustrated graphically. The latter is approximated by a power of a sine function. Data are tabulated for monthly measurements at Lindau(Harz) in support of the expression. (BBB)

9211 ARE THERE COSMIC INFLUENCES ON THE WEATHER. Moeller, Fritz (Univ., Munich). Bild Wiss., 4: 493-500(June 1967). (In German).

Correlations between the weather and extraterrestrial phenomena are reviewed. The relation of the proximity of the Earth to the Sun and the relation of received solar energy with sunspot activity are dispensed with. But correlations are observed in the upper atmosphere, and there are unusual correlations, such as the water level of Lake Victoria with solar activity, and the vegetation period of the horse chestnut in the Rhine region with sunspot frequency. Other predictive correlations on rainfall in central Europe have been found to have a probability of 65%. Influences of the Moon on weather are expected to be great by extrapolation from tidal effects on the oceans, and statistical effects on atmospheric pressure apparently exist. These cycles have been established by examination of meteorological data on several continents. A correlation between precipitation and the phase of the Moon has also been observed, but no explanation has been evinced. (BBB)

9212 ULF AND MICROPULSATIONS. PART III. RELATIONS BETWEEN HYDROMAGNETIC EMISSIONS AND PERTURBATIONS OF THE MAGNETOSPHERE. Gendrin, R. Ann. Geophys., 23: 299-31(Apr.-May-June, 1967). (In French).

Interaction of the solar wind with the magnetosphere produces multiple effects; particulate precipitation in the vicinity of auroral zones, magnetosphere contraction effects, displacement of the edge of the plasmapause, and other results are discussed. Low altitude phenomena are also possibly related. There is a correlation between magnetic disturbance and the Doppler effect observed in the reception of hf signals reflected by the ionosphere. The interactions between particles and hydromagnetic waves may be studied by extending the number of magnetic measurements to determine that portion of effects due to local electrojets, satellite measurements of the oscillation level (vlf or ulf) to determine absorption phenomena which can distort apparent modulations, and simultaneous determination of particle flux and electromagnetic field intensity at different altitudes. Several relations between frequency distortion and magnetosphere deformation are explored, in particular correlation between magnetic oscillation and simultaneous appearance of an IPDP. Direct correlations with the solar wind are also discussed. (BBB)

9213 ON THE INFLUENCE OF PAIRING IN AN ELECTRON–ION GAS ON PHENOMENA OF IONOSPHERIC AMPLITUDE–AMPLITUDE INTERMODULATION. Tiberio, Ugo (Univ., Pisa, Italy). Alta Freq., 36: 186-91(Mar. 1967). (In Italian).

The theory of amplitude–amplitude intermodulation in the ionosphere is developed on the assumption of electromagnetic interaction in the electron–ion gas and that the distribution of velocities is Maxwellian. Results predicted on the bases of these hypotheses are not in good agreement with experiment. Experimental work on retrodiffuse waves in the ionosphere shows the existence of a marked electromagnetic interaction between the two charged gases. A new pairing factor is thus introduced into the theory to account for energy exchange associated with the interaction. A simplified theory of the Lussemburgo effect is introduced, which is essentially reduced to the energy balance of an electron gas. When this is applied to a practically possible case, the predictions are in good accord with observed results for unitary pairing. Experimental research on the effect are suggested; a microwave model may be studied in the laboratory. (BBB)

9214 STUDY OF THE TEMPORAL CONSTANTS IN THE FORMATION OF A SPORADIC E LAYER UNDER THE SHEARING EFFECT OF THE WIND. Nguyen Minh Tri (CNRS, St. Maur-des-Fosses, France). Ann. Geophys., 23: 285-98(Apr.-May-June 1967). (In French).

An investigation was made of the development with time of sporadic E layers of the ionosphere formed under the influence of a neutral horizontal wind field containing strong vertical gradients. The results obtained in the general case, which considers simultaneously the phenomena of diffusion and recombination, showed that if the ions forming the layers possess a lifetime very great compared to the time scale of the wind system, then the stationary solution is no longer valid, even approximately. On the other hand, the changes in the density can be studied using a simple model, the properties of which are presented. (BBB)

9215 SCATTERING AND ABSORPTION OF FAST ELECTRONS IN THE UPPER ATMOSPHERE. Maehlum, Bernt (Rice Univ., Houston, Tex.); Stadsnes, Johan. Phys. Norv., 2: 111-22 (1967).

The transport equation for fast electrons in the upper atmosphere was solved numerically indirectly by a Monte Carlo method. Because of incomplete knowledge of the various cross sections for interaction between the atmosphere and the fast electrons the results of the computations are only considered as a working model, which has to be compared with particle observations in the upper atmosphere. A few relevant satellite and rocket observations showed fair agreement with the Monte Carlo computations described. Other aspects of the absorption of electrons considered included absorption of a nonvertical beam of fast electrons. According to the Monte Carlo computations, ionization produced in the atmosphere by a beam of fast, monoenergetic electrons is confined to a restricted altitude range, even when the primary electrons have a broad pitch angle distribution. The shape of the ionization profile is governed by the energy distribution of the primary electrons rather than their angular distribution. The ionization produced by an electron beam coming from a nonzenithal direction is much less than the ionization produced by a beam from zenith. Hence, an electron from zenith will on an average produce about 10 times as many ion pairs near the maximum as an electron with a 70 to 90° direction of arrival. (BBB)

9216 ACCESSIBILITY BY PROPAGATION TO RESONANCES OF VERY LOW FREQUENCY IN THE IONOSPHERE. Cerisier, J. C. (CNRS, St. Maur-des-Fosses, France). Ann. Geophys., 23: 249-66(Apr.-May-June 1967). (In French).

Accessibility by propagation to resonances in the magnetosphere was studied for very-low-frequency waves (whistlers). At frequencies in the range between the electron gyrofrequency and the lower hybrid frequency, a particular value of the angle between the wave normal and the magnetic field makes the refractive index infinite. Haselgrove's ray tracing method was used and a formalism was developed that made it possible to interpret the ray path as a function of the various gradients that exist in the ionosphere. The electron gyroresonance is accessible only for waves propagating along the dipole axis. The oblique resonance is accessible in equatorial regions at altitudes where the electron density gradient is low. A characteristic length for the approach to resonance was introduced for a quantitative study of this topic. (BBB)

9217 NOCTILUCENT CLOUDS OVER WESTERN EUROPE DURING 1966. Paton, J. (Univ. of Edinburgh). Meteorol. Mag., 96: 187-90(June 1967).

A description is given of each occurrence of noctilucent clouds (NLC) in 1966 over Western Europe, and the relation of NLC and other auroral phenomena to sunspot activity is discussed. A table contains an account of displays of NLC compiled from reports from observers in Norway, Denmark, Holland, the British Isles, and Greenland and from crews of aircraft. Data given include the maximum elevation above the northern horizon and limiting azimuths of the cloud field recorded at selected stations at stated times during the display. The latitude and longitude of each station are given. The frequency of occurrence of NLC was slightly greater than during 1965 and some of the displays, notably those of June 27–28 and June 30–July 1 were spectacular. During each of the last 3 yr over the period of sunspot minimum, the clouds have been seen in Britain on over 20 nights. By contrast, during the summers of 1957 and 1958 at the time of sunspot maximum, when careful watch of the sky was being kept by International Geophysical Year observers, the clouds were seen on only 2 occasions. Since the clouds are now generally believed to consist of ice crystals that have formed on a nucleus of cosmic origin, the pronounced maximum in their occurrence at sunspot minimum suggests that the temperature at the mesopause (80 km) where they are situated is then at a minimum, providing the physical conditions leading to the formation of ice crystals. (BBB)

9218 ROCKET-BORNE OBSERVATIONS OF NATURAL VLF NOISE IN THE COURSE OF AN AURORA. Beghin, C. (CNRS, St. Maur-des-Fosses, France). Ann. Geophys., 23: 275-84(Apr.-May-June 1967). (In French).

Very low frequency radio noise and related auroral phenomena, recorded in Iceland between 19 August and 6 September, 1967, are presented. Natural emissions were observed simultaneously, by ground-based and rocket-borne receivers, during an auroral display. Auroral chorus was detected between 500 and 1500 Hz. It is shown that the waves propagated through the ionosphere under quasi-longitudinal conditions. The minimum value of the attenuation found, at 700 cps, was of the order of 38 db. Quasi-periodic emissions with periods of about 35 sec were observed simultaneously with magnetic micropulsations and auroral coruscations of the same period. It is suggested that these emissions were triggered by high-energy electrons, the precipitation of which was modulated by hydromagnetic waves. (BBB)

9219 THE DISPLAY OF THE AURORA OF 13, SEPTEMBER 1957. Schroeder, Wilfried. Beitr. Geophys., 76: 11-14(1967). (In German).

Solar and geomagnetic data are examined in connection with the aurora of Sept. 13–14, 1957. The events of Sept. 13, 1957 can be correlated with increased flare activity (Sept. 11: flares, class 1+, 2, 3; Sept. 12, class 1+, 2). The aurora was observed in the northern hemisphere to latitude $\Phi = 65-64°$, and in the southern hemisphere to $\Phi = 34°$. Complete display was not achieved in the northern hemisphere because of the unfavorable conditions, but the southern hemisphere observation of a rather active aurora suggests that the unusual solar behavior led to an aurora of fairly large size. The results for the red display may be related to the known observations of Feb. 11, 1958, July 8, 1958, and others. Q indices at Kiruna (Sweden) fell between 6 and 9. (BBB)

9220 STATISTICS OF RED AURORAE. Schroeder, Wilfried. Beitr. Geophys., 76: 15-17(1967). (In German).

Red aurorae observed from 1946 to 1950 are correlated with solar pnenomena. Thirteen cases are reported; in each the Kp index is large, with great majority of observations having been made on days with maximal disturbance ($Kp \geq 7$). The number of observed red aurorae parallels the sunspot cycle, with the minimum number of observations found during the minimum of the cycle. Other data from between 1874 and 1960 are cited to support the correlation. The greater occurrence of rays in periods of maximal solar activity and the greater range of color in rays should be correlated similarly. Maximum activity for red aurorae was found in Denmark to come in September, as for the other aurorae. After 1951 no more truly red aurorae were seen until the new maximum in 1957. (BBB)

9221 CONDITIONS OF SELF-EXCITATION OF THE GEOMAGNETIC DYNAMO MODEL. Gailitis, A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 45-54(1967). (In Russian).

The laboratory model of the geomagnetic dynamo, representing the spherical volume with a given internal fine-scale limitation of the flow of liquid metals, is examined. The conditions for self-excitation are established by the solution of electrodynamic equations, neutralized by fine-scale motion. The distribution of the magnetic field and currents was determined. (tr-auth)

9222 INTERRELATIONS OF UPPER ATMOSPHERE DISTURBANCE PHENOMENA IN THE AURORAL ZONE. Oguti, T. (Tokyo Univ.). JARE Sci. Rep., Spec. Issue No. 1, 29-52(Feb. 1967).

Interrelations of the phenomena of upper atmosphere disturbances in high latitudes, such as magnetic disturbances, auroral displays, anomalous ionization in the ionosphere, x-ray and radio-wave emissions, are discussed with special reference to the quantitative aspects of the disturbances and to the spatial distribution of disturbance area. As to the quantitative relations, the effects of primary electron beams, for example, ionization, excitation, and emission of x rays and radio waves, were shown to be consistent with the observational results, though a considerable scattering of numerical values occurred owing to the fluctuation of energy spectrum of primary electrons. Examination of spatial distribution of disturbance area led to the conclusions that: (1) the electron precipitation responsible for various disturbance phenomena can be divided into 3 groups, i.e., the flash precipitation group, quasi-steady precipitation group, and noon precipitation group; and (2) these groups correspond, respectively, to the electron precipitation from the open–close boundary of magnetic lines of force in geomagnetic cavity, to the electron precipitation from the trapping region, and to that from neutral regions of cavity surface in the day side. (BBB)

9223 ON THE FORENOON ANOMALY OF THE DIURNAL VARIATION OF THE NORMAL E LAYER OF THE IONOSPHERE. Singler, A. (Heinrich-Hertz-Institut, Berlin-Adlershof, Ger.). Z. Meteorol., 19: 60-2(1966). (In German).

Daily variations in the normal E layer of the ionosphere were interpreted in terms of the Chapman theory based on the relation between the critical frequency of the E layer and the solar zenith angle. Shortly before noon (local time) an anomaly occurs in the critical frequency relating to fluctuations in the ionizing radiation. The time of development of this forenoon anomaly in the diurnal variations of the critical frequencies of the normal E layer (slowing down of the increase of electron density shortly before local noon as compared to the Chapman layer) was computed on the basis of simplified assumptions for 80 selected days of the year 1958. The results were in agreement with the Appleton hypothesis. (BBB)

9224 A STUDY OF ENERGETIC ELECTRONS IN THE RADIATION BELTS WITH HITCH-HIKER I. Paolini, F. R.; Theodoridis, G. C. (American Science and Engineering, Inc., Cambridge, Mass.). Ann. Geophys., 23: 237-48(Apr.-May-June 1967).

A survey of relativistic electrons in the Van Allen radiation belts was performed in July and August, 1963, a period of relative solar quiet, with instruments on board the polar-orbiting Air Force Subsatellite Hitch-hiker I. Perpendicular intensity maps, energy spectrums, and pitch angle distributions are presented for electrons between 0.7 and 4 MeV. Peak inner belt intensities for electrons above 1 MeV were about 5×10^6 electrons/cm^2-sec-ster, (at $R, \lambda \approx 1.35, 0$). Inner belt spectrums were consistent with an exponential shape, $\exp(-E/E_0)$, with $0.7 \leq E_0 \leq 1.5$ MeV, although in the region $(B, L) \approx (0.21, 1.25)$ the shape was not inconsistent with a fission spectrum modified by atmospheric scattering, within the accuracy of the measurement. Maximum observed intensities of electrons above 1 MeV in the horns of the outer belt were about 10^5 electrons/cm^2-sec-ster. Outer belt intensities varied substantially, with severe depletions at times of even relatively mild magnetic and solar activity. Subsequent recoveries required periods of a few to several days, the recovery process requiring a source on the order of 10^{13} to 5×10^{13} erg/sec at particle energies above 0.7 MeV. Outer belt spectrum shapes between 0.7 and 4 MeV were exponential with $E_0 = 0.35 \pm 0.15$ MeV. Loss of outer belt electrons through dumping in the anomaly at rates up to 2×10^{11} erg/sec was inferred from the data. (BBB)

9225 OBSERVATIONS OF THE DAY AIRGLOW DURING THE TOTAL SOLAR ECLIPSE OF MAY 30, 1965. Moore, James G. (Naval Ordnance Test Station, China Lake, Calif.); Rao, C. R. Nagaraja. Ann. Geophys., 23: 197-206(Apr.-May-June 1967).

Visual dayglow emissions at λ 3914 Å (N_2^+) and 6300 Å (OI) were detected aboard a C-135 aircraft flying at 40,000 ft over Bellingshausen Atoll (154°00′W, 15°05′S) in the Pacific Ocean. Emission lines and reference continuum spectral intervals were isolated by narrow band (bandwidth ~ 10 Å) interference filters. During totality the ratio of the intensity (relative) of the emission line at λ 3914 Å to the intensity of the continuum at λ 4000 Å increased by about 100% in the shadow zone near the zenith as compared to the value prevailing at a zenith distance of 78°; the corresponding ratio for the emission line at λ 6300 Å with respect to continuum at λ 6200 Å increased by slightly >100%. The origin of the λ 3914 Å emission is attributed to the well-established excitation mechanism of resonant scattering of sunlight outside the shadow zone by pre-existing N_2^+ molecules. The apparent enhancement towards the zenith is due to the contrast provided by the darkened shadow zone during totality. The observed λ 6300 Å emission was in part attributed to the collisional excitation of atomic oxygen by thermal electrons. The F1 ionospheric region, generally considered the site of origin of this emission, probably was rendered distinct during this eclipse. (BBB)

9226 EXTENSION OF THE THEORY OF MODES IN THE CASE WHERE THE PROPERTIES OF THE IONOSPHERE AND THE SOURCE ARE DEPENDENT ON THE DIRECTION. Broche, P. (Laboratoire de Physique de l'Exosphere, Orsay, France). Ann. Geophys., 23: 267-74(Apr.-May-June 1967). (In French).

A theoretical solution is given to the problem of the excitation of the earth–ionosphere waveguide by a vlf source, when the properties of the source and of the ionosphere, assumed to be plane and anisotropic, are dependent on the azimuth. A discussion of the concept of waveguide mode is given. An asymptotic development is derived, showing that, far away from the source, the results can be obtained by assuming appropriate isotropic waveguide and source. Formulas are also given for the case of an isotropic waveguide, whatever the source may be, and are applied to a simple case. (BBB)

9227 THE EARTH'S TRAPPED RADIATION BELTS. pp 76-106 of Radiation and Shielding in Space. Haffner, James W. New York, Academic Press, 1967.

Discussions are given on the following: (1) introduction, (2) theories of particle motion in magnetic fields, (3) characteristics of trapped radiation belts, (4) theories pertaining to trapped radiation belts, and (5) artificial trapped radiation. 87 references. (M.O.W.)

9228 IONOSPHERIC EFFECTS CAUSED BY ELECTRONS PRECIPITATED FROM THE OUTER RADIATION BELT. Torr, D. G.; Torr, M. R. (National Inst. of Telecommunications Research, Johannesburg). Nature (London), 216: 1193-4 (Dec. 23, 1967).

During the period October 1962 to March 1963 a disturbance was observed in the ionosphere at the Antarctic station Sanac whenever a high flux of precipitated electrons was observed in the magnetically conjugate area by the satellite Alouette. The present authors observed that similar disturbances were produced at other stations lying near the same magnetic shell ($L = 4$) in both the northern and southern hemispheres, and established that flux values above a certain level were observed only when the ionosphere was disturbed; also that the percentage of total time for which that level was exceeded at each station was almost exactly the same as the percentage time for which the ionosphere was disturbed. Results showed that the frequency of occurrence of ionospheric disturbances on $L = 4$ increased markedly in the vicinity of the S. Atlantic geomagnetic anomaly. This is attributed to the fact that the mirror points of particles trapped in the outer radiation belt are much lower there than anywhere else, being responsible for the observed high intensities of charged particles. There seems to be no reason why these effects should be confined to the shell $L = 4$, and evidence in support of this is outlined. It seems probable that electron bombardment could be an important cause of ionospheric disturbances at all sites which lie below the outer radiation belt. The behavior of the ionosphere was examined at each of a large random sample of 2 hr periods at several northern and southern hemisphere stations lying on the shells $1.88 \leq L \leq 4.47$ for the period October 1962 to March 1963. A difficulty is that the disturbances sometimes occur on magnetically quiet days, and values obtained are to be regarded as relative. The finding that the frequency of occurrence of ionospheric disturbances increases over the S. Atlantic geomagnetic anomaly, as in the case of $L = 4$, strongly suggests that the correlation between electron flux and ionospheric disturbances found at $L = 4$ will persist at all sites which lie below the outer radiation belt. The longitudinal variation in the behavior of the ionosphere at locations below the outer radiation belt was also examined. It is suggested, from the results, that corpuscular bombardment of the atmosphere may give rise to two competing effects: an increase in electron density because of direct ionization, and a decrease because of a temperature increase which may increase both the scale height and the effective combination rate. (UK)

9229 DISTRIBUTION OF THE ABSORPTION OF RADIOWAVES IN THE IONOSPHERE ALONG THE TRAJECTORY OF RADIO WAVES DURING VERTICAL PROBING. Tukhashvili, K. I. (Tbilisi State Univ., USSR). Soobsh. Akad. Nauk Gruz. SSR, 47: 567-70(Sept. 1967). (In Russian).

The absorption of radiowaves in the ionosphere, measured by the A1 method, is described as the sum of the absorption at each individual layer of the ionosphere. Experiments showed that the radiowaves with frequency of 5.5 MHz during passage through the F1 layer up and down undergo absorption equal to 20 to 25% of the midday absorption, during reflection from the F layer. The remaining 75 to 80% of the absorption occurs on reflection planes (in the F layer) and in the D and E layers. More than 40% occurs in the D and E layers and less than 35% in the F layer in the reflection range. At frequencies of 2.2 and 5.5 MHz, for dry soil, the reflection coefficients of the Earth were measured. They were 0.68 and 0.58, respectively. (tr-auth)

9230 PROPAGATION OF VLF WAVES BELOW ANISOTROPIC IONOSPHERE MODELS WITH A DIPPING STATIC MAGNETIC FIELD. Galejs, Janis (Sylvania Electronic Systems, Waltham, Mass.). Radio Sci., 2: 1497-1512(Dec. 1967).

A semi-infinite homogeneous ionosphere with a dipping static magnetic field is used as an approximation to the upper region of a cylindrically stratified ionosphere model. The presence of a vertical static magnetic field component is neglected in the lower stratified regions. The presence of TM modes in the space between the earth and the ionosphere excites coupled TE and TM modes in the upper half space, and these TE fields also propagate in the cylindrically stratified region and in the space between the earth and ionosphere. The TE waves modify the effective surface impedance for the TM modes and the propagation parameters are determined by an iterative solution of the modal equation. Propagation parameters are calculated numerically for a homogeneous sharply bounded ionosphere and also for stratified ionosphere models. The interference distance D of the two lowest waveguide modes is increased for propagation in the east-to-west (EW) direction relative to the west-to-east (WE) direction for frequencies less than 25 kHz and for the angles between the vertical and the direction of the static magnetic field in the range of 20 to 60°. These results are consistent with the recently reported measurements by Crombie (1966). The attenuation rates computed for the sharply bounded ionosphere model are in excess of 5 dB/1000 km for EW direction of propagation, but are lower in the stratified ionosphere models. (auth)

9231 PROPAGATION OF SELF-SIMILAR RADIATION WAVES. Chow, Chuen-yen (Univ. of Notre Dame, Ind.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 2281-3(Dec. 1967).

Under the assumption of invariant density immediately after an explosion, it can be shown that self-similar solutions are possible if either the radiation energy is negligible compared with the material internal energy or vice versa. In the present analysis it is assumed that initially an amount of heat is distributed in a high temperature region that is separated from the cold surrounding by an imaginary surface at a distance from the center of the coordinate system. The hot region has a symmetric plateau-like temperature distribution with initial central temperature, whereas the temperature of the surrounding gas is so low compared with that of the hot gas that it can be considered as zero. (W.D.M.)

9232 RESPONSE OF IONOSPHERIC ELECTRON DENSITY TO A CHANGE OF ELECTRON TEMPERATURE. Pound, Thomas Ronald. Urbana, Ill., Univ. of Illinois, 1967. 225p. Thesis.

The F2 region of the ionosphere was investigated using a transport-production spatial model. In this model the F2 region is assumed to be lossless, while the lossy lower region of the ionosphere is represented by an electron sink. A temporal model was used in which the transition from day to night is represented by a step function change of the production rate of ionization and electron temperature. The main emphasis of the work was to study the effect of a change of electron temperature for ionospheric conditions near a sunspot minimum. The seasonal anomaly in both the midday f_0F2 and electron content near sunspot minimum was investigated by including not only a flux of ionization out of the summer ionosphere and into the winter ionosphere, but also by including a seasonal change of electron temperature. Reasonable agreement was found between the theory and experiment. The winter nighttime ionosphere was investigated by using the static model with no production and a flux of ionization into the region. Electron content, f_0F2, slab thickness, and ratio of electron content above the peak to that below was found to agree reasonably well with experimental results. An experimental technique of standing wave analysis, designed to measure electron density from rocket signal strength measurements in the E region, is outlined and its theory is discussed. This method is found to be particularly useful in the study of the structure of Sporadic E. Outlines of the experimental techniques currently used for the exploration of the ionosphere are also presented. Finally, quantitative estimates based on available data, of the heat energy input to ambient electrons from photoionization, conduction through electrons, and Joule heating are made. (Disser. Abstr.)

Low-Temperature Physics

Refer also to abstracts 8296, 8783, and 9728.

9233 (EGG-1183-4002) INTERFACE OF TWO SUPERCONDUCTORS. Final Report, FY 67. West, B. G. (EG and G, Inc., San Ramon, Calif.). Aug. 7, 1967. Contract AT-(29-1)-1183. 70p. Dep. CFSTI.

The first step in a program designed to develop a detailed understanding of superconductors at an interface is reported. A set of lecture notes for a series of six seminars about the BCS (Bardeen-Cooper-Schrieffer) and related theories, and the groundwork leading up to them are presented. The theoretical research completed is indicated at the end of the series. (auth)

9234 (ORNL-TM-2075) MAGNETIC FLUX FLOW AND SUPERCONDUCTOR STABILIZATION. Quarterly Report, July 1-September 30, 1967. Gauster, W. F.; Efferson, K. R.; Hendricks, J. B.; Kroeger, D. M.; Lubell, M. S. (Oak Ridge National Lab., Tenn.). Dec. 1, 1967. Contract W-7405-eng-26. 66p. Dep. CFSTI.

Work on flux flow of a bare strip of superconducting Nb-25% Ti, on the current-voltage characteristics on short samples of commercially available stabilized Nb−Ti conductors, and on heat transfer from a cylindrical metal surface to liquid helium have been continued. An analysis of the test data obtained with the bare Nb−25% Ti strip suggested that the flux flow stability can be better understood by considering the take-off current instead of the take-off power. The current−voltage characteristics of the stabilized wires were indicative of a heat transfer law in the form $Q = h^* \tau^n$ with $n \simeq 2.5$. Test results obtained with poorly stabilized samples could be explained by considering the simultaneous occurrence of sections in the superconducting and in the normal state, or in the superconducting and in the flux flow state. The measurements of heat transfer from metal surfaces to liquid helium have been appreciably improved. (auth)

9235 SUPERCONDUCTIVE MAGNETS. II. APPLICATIONS. **Montgomery, D. Bruce** (Massachusetts Inst. of Tech., Cambridge). Mech. Eng., 89: 36-43(Mar. 1967).

Four general applications of superconductivity, grouped according to basic principles, are considered: (1) The ability to carry loss-less currents, leading to the production of magnetic fields for use with survey instruments (mass spectrometer, high-energy particle analysis), MHD generators, pulse and continuous duty studies of the properties, or control of, high density thermonuclear plasmas, ion propulsion systems, MHD propulsion for ships, electron and charged particle optics, acceleration, and analysis, and radiation shields; (2) Flux exclusion properties, leading to devices like ultra-high-speed frictionless spin-up motors, frictionless bearings, zero field chambers, special field shapes, either homogeneous or sharp gradients, and rf cavities with very high Q; (3) Quantized flux structures in devices such as very sensitive magnetometers, amplifiers, and electromagnetic standards; (4) Change of properties at the critical field, current, or temperature in devices like ac-dc converters with superconducting rectifiers, d-c generators and flux pumps, light-weight memory and logic devices, superconducting tunnel diode devices, and energy conversion devices. Superconductor properties other than their ability to carry lossless currents are also discussed, such as the Meissner effect, i.e., the ability of certain superconducting spheres to expel magnetic field from their interior when they are cooled in a magnetic field. Another property considered is the fact that a closed superconducting ring will contain only an integral number of flux quanta. Classes of superconductors are examined in terms of Type I (also called soft or ideal) superconductors which include many metallic elements like Rb, Sn, and Hg; and Type II (or hard, nonideal) superconductors which include the high field alloys and compounds like Nb−Zr and Nb−Sn. Approximate critical field and transition temperature values of some superconductors are tabulated. The application of magnetic fields generated by lossless currents is considered in detail. (BBB)

9236 THERMAL FORCE ON VORTICES IN SUPERCONDUCTING LEAD FILMS. **Huebener, R. P.** (Argonne National Lab., Ill.). Solid State Commun., 5: 947-50(Dec. 1967).

The Nernst voltage in the intermediate state of superconducting lead films was measured as a function of the film thickness, which ranged between 5 and 110 k Å. Above about 10 k Å the Nernst voltage decreased with increasing film thickness. For a 14-k Å film the entropy per flux quantum associated with a vortex of unit length was determined and found to be 1 to 2 orders of magnitude larger than the value calculated for a very large flux bundle, where the surface energy contribution is negligible. (auth)

9237 SUPERCONDUCTIVITY IN THE SPINELS $CuRh_2S_4$ AND $CuRh_2Se_4$. **Robbins, M.** (Bell Telephone Labs., Inc., Murray Hill, N. J.); **Willens, R. H.; Miller, R. C.** Solid State Commun., 5: 933-4(Dec. 1967).

Superconductivity has been observed for the first time in compounds with the spinel structure. Transition temperatures of 4.35 and 3.50°K were measured for $CuRh_2S_4$ and $CuRhSe_4$, respectively. (auth) (UK)

9238 DIRTY SUPERCONDUCTORS AND ISOTOPE EFFECT. **Gusman, G.** (Univ. Libre, Brussels). J. Phys. Chem. Solids, 28: 2327-33(Nov. 1967).

The isotope effect in transition metal superconductors is reexamined. The approximate calculations of Garland are shown to be qualitatively justifiable in the limit of sufficient dirtiness, i.e., $\omega_D^{-1} \sim \tau \gg \epsilon_F^{-1}$ where ω_D is the Debye frequency, ϵ_F the Fermi energy of electrons and τ the relaxation time of electrons due to impurity scattering. A necessary condition for Garland's calculation to be valid is that the effective mass ratio m_d^*/m_s^* be not greatly in excess of unity. If this condition is violated, which appears to be the case in such alloys as Nb_3Sn, then a modification ensues wherein the cutoff of Garland corresponding to the band width is replaced by the d band plasma frequency. (auth) (UK)

9239 INFLUENCE OF NONMAGNETIC IMPURITIES ON SUPERCONDUCTORS WITH OVERLAPPING BANDS. **Sung, C. C.; Wong, Victor K.** (Ohio State Univ., Columbus). J. Phys. Chem. Solids, 28: 1933-40(Oct. 1967).

The two-band model proposed by Suhl, Matthias and Walker (Phys. Rev. Lett., 3: 552(1959)) is used to investigate the influence of nonmagnetic impurities on superconductors with overlapping bands. The use of the experimentally inferred information that both the density of states and the gap parameter of the d-band are much greater than that of the s-band simplifies the calculation of the density of states and the temperature dependence of the gap parameter. It is found that the dominating effect of the nonmagnetic impurities is to increase the energy gap of the s-band. The electronic specific heat at low temperatures is found to decrease more rapidly than the experimental data indicate. At zero temperature the Meissner effect is unaffected by the nonmagnetic impurities, while the threshold for electromagnetic absorption is increased. (auth)

9240 THERMAL CONDUCTIVITY AND HEAT CAPACITY OF 7740 PYREX BELOW 4°K AND IN MAGNETIC FIELDS TO 90 kG. **Fisher, R. A.; Brodale, G. E.; Hornung, E. W.; Giauque, W. F.** (Univ. of California, Berkeley). Rev. Sci. Instrum., 39: 108-14(Jan. 1968).

The thermal conductivity of Pyrex 7740 glass has been measured over the temperature range 0.4 to 4°K and in magnetic fields from 0 to 90 kG. As expected, the conductivity was unaffected by the field. The glass had an iron content of 0.02%. The heat capacity of Pyrex, at constant magnetic fields, has been measured over the above range of temperature and field. There was a considerable field effect due to the iron content. The variation of temperature with field was measured on a series of isentropes and this enabled the evaluation of the entropy. The change of temperature of Pyrex during adiabatic demagnetization at various values of the entropy is shown as a graph for this typical sample. A description of the apparatus used for the measurement is included. (auth)

9241 NEW LIQUID ^{4}He EXPERIMENTAL CRYOSTAT. **McAdams, H. H.** (Rice Univ., Houston, Tex.). Rev. Sci. Instrum., 39: 130-1(Jan. 1968). (ORO-1316-46).

A helium cryostat is described which is useful in experiments where it is desirable to maintain a bath temperature of about 0.9°K, while at the same time minimizing the distance from the helium bath to the Dewar lid. The design also allows easy vertical adjustments of the Dewar during the course of an experimental run. (auth)

9242 CRYOSTAT FOR RADIATION DAMAGE EXPERIMENTS. **Peters, P. B.; Shearin, P. E.** (Univ. of North Carolina, Chapel Hill). Rev. Sci. Instrum., 39: 77-80(Jan. 1968).

A cryostat designed especially for the performance of experiments where metals at low temperatures are irradiated by high energy electrons is described. This device is ideally suited for isochronal anneal studies of the recovery spectrum following irradiation. The sample holder used is also described. (auth)

9243 FIELD DEPENDENCE OF THE SUPERCONDUCTING PROPERTIES INDUCED BY PROXIMITY EFFECTS: BREAKDOWN FIELDS. Phys. Kondens. Mater., 6: 307-24(1967).

It has been shown that the proximity-effect-induced superconductivity in the normal part N of a superconductor-normal metal binary layer (such as In Bi/Zn) can screen a magnetic field up to a critical field H_b. At H_b, a sharp penetration of flux into N occurs. However, the breakdown field H_b can only be observed for certain values of the thickness of N and of temperature. The domain of existence of H_b as a function of these two parameters is studied. It is shown that studies on H_b yield some information on the properties of the pair potential in N. Thus measurements on H_b performed at the critical temperature of N confirm the theoretical predictions concerning the remarkable behavior of the order parameter in N at this temperature. (auth)

9244 ABSORPTION AND SCATTERING OF LIGHT BY EXCESS ELECTRONS IN LIQUID HELIUM. **Fomin, I. A.** (Moscow Physical-Technical Inst.). JETP Lett. (USSR) (Engl. Transl.), 6: 196-8(Sept. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 715-18(Sept. 15, 1967).

Estimates of the magnitude of the effects connected with transitions of electrons between levels when a beam of light passes through He containing excess electrons are presented. The "electron inside a bubble" system is assumed. In calculating the frequencies of the absorption lines and the values of the absorbed energy, the deformational oscillations of the bubble are disregarded. Raman scattering and the effects of pressure on the system are considered. (A.G.W.)

9245 THE FUTURE OF SUPERCONDUCTIVITY. **Little, William A.** (Stanford Univ., Calif.). Bild. Wiss., 4: 472-9 (June 1967). (In German).

A history of research in superconductivity is given, beginning with the experiments of Kammerlingh Onnes. A description of electron pairing is given. The development of strong-magnetic-field construction using superconductors is traced. Their uses in plasma research and in outer space research are elaborated. Uses of superconductors in high-frequency current problems are suggested, and the influence of these needs on technology of superconductors is recounted. The problems of ultralow temperatures are related to the discovery of superconducting alloys, and the search for alloys with higher jump temperatures is described. Some discussion of the relation of jump temperature to composition is given. In particular, the search for new organic superconductors at relatively high temperatures is outlined. (BBB)

9246 JOULEAN DISSIPATION IN HARD SUPERCONDUCTING TUBES AND CYLINDERS. Wischmeyer, C. R. (Rice Univ., Houston, Tex.). Phys. Lett., 25A: 762-3(Nov. 20, 1967).

By a simple argument, it is shown that a uniformly changing axial magnetic field produces power densities which are easily compared on the basis of geometry and electromagnetic history. (auth)

9247 ON THE CONVERGENCE OF PERTURBATION EXPANSIONS IN CLEAN TYPE-II SUPERCONDUCTORS. Houghton, A.; McLean, F. B. (Brown Univ., Providence). Phys. Lett., 25A: 736-7(Nov. 20, 1967).

Transport coefficients of clean type-II superconductors are expanded in powers of the order parameter. The convergence of these series is discussed. (auth)

9248 ON THE EXISTENCE OF ZERO SOUND IN ^{3}He–^{4}He MIXTURES. Etters, R. D. (Douglas Advanced Research Labs., Huntington Beach, Calif.); Raich, J. C. Phys. Lett., 25A: 711-12(Nov. 20, 1967).

The existence of zero sound in ^{3}He–^{4}He mixtures is predicted on the basis of a self consistent field theory. It is shown that the phonon excitation of pure ^{4}He, and the zero sound mode associated with pure ^{3}He, belong to the same branch and evolve continuously into each other as the concentration of ^{3}He in the mixture is changed. (auth)

9249 BOUNDARY SCATTERING IN SUPERCONDUCTORS. Gregory, William D. (Georgetown Univ., Washington, D. C. Massachusetts Inst. of Tech., Cambridge). Contract AT(40-1)-3665. Phys. Rev. Lett., 20: 53-6(Jan. 8, 1968).

Boundary scattering in gallium single crystals produces little shift of the superconducting critical temperature T_c consistent with the assumption of specular reflection of quasi particles at the sample boundary. (auth)

9250 MICROSCOPIC THEORY OF THE BACK-FLOW EFFECT IN He II. Yamasaki, Shuichiro; Kebukawa, Takeji; Sunakawa, Sigenobu (Osaka Univ., Toyonaka, Japan). Progr. Theor. Phys. (Kyoto), 38: 804-12(Oct. 1967).

The back-flow effect in liquid helium II is studied under the assumption that interparticle potential is strong. The method devised by Lee, Low, and Pines is applied to the system that consists of an impurity atom and the Bogoliubov quasi particles. The dipolar back flow and the effective mass of the impurity atom are calculated. It is shown that they are insensitive to the detained knowledge of the strong interaction. The same method is applied to the problem of a moving source interacting with a neutral scalar field. (auth)

9251 DILUTE SOLUTION OF ^{3}He IN SUPERFLUID ^{4}He. I. A DILUTE GAS MODEL CALCULATION. Tsuzuki, Toshio; Tsuneto, Toshihiko (Kyushu Univ., Fukuoka. Osaka Univ., Toyonaka, Japan). Progr. Theor. Phys. (Kyoto), 38: 745-66 (Oct. 1967).

The properties of the fermion quasi particles in a dilute solution of fermions in a low-density boson gas at the absolute zero of temperature are investigated, assuming that a bare interaction between any pair of particles is an identical isotropic potential of repulsion. An approximation of scattering amplitudes to the interactions is employed. Formulas for the chemical potential, the effective mass and the excitation spectrum of the fermion quasi particle are given noting the differences between the case of a single impurity and the case of a dilute uniform solution. The effective interaction between the fermion quasi particles in the limit of small momentum transfer is given by the sum of the direct interaction between the quasi particles and the induced interaction due to the exchange of a virtual excitation of bosons, and becomes weakly attractive. The dependences of the effective interaction on the momentum transfer and the velocities of the interacting quasi particles are also studied. Furthermore the expression for the ground-state energy of the system is given. (auth)

9252 FRIEDRICHS–BEREZIN TRANSFORMATION AND ITS APPLICATION TO THE SPECTRAL ANALYSIS OF THE BCS REDUCED HAMILTONIAN. Kato, Yusuke; Mugibayashi, Nobumichi (Kobe Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 813-31(Oct. 1967).

Friedrichs and Berezin's theory on the diagonalization of the boson quadratic Hamiltonian is reformulated, and is generalized so as to permit its application to the spectral analysis of Bardeen, Cooper, and Schrieffer's reduced Hamiltonian in the theory of superconductivity. The generalization consists in allowing an operator, assumed as strictly positive in the original theory, to have zero and negative eigenvalues with finite multiplicity. It is found that if the operator has only an additional zero eigenvalue the quadratic Hamiltonian remains lower semibounded, while it is necessarily unbounded if a negative eigenvalue appears. The BCS reduced Hamiltonian, or rather its equivalent boson Hamiltonian, with a separable interaction falls under the former case. A similar reformulation for the fermion quadratic Hamiltonian is also appended. (auth)

9253 PARAMAGNETIC IMPURITY EFFECT IN DILUTE SUPERCONDUCTING La ALLOYS. Sugawara, Tadashi; Eguchi, Hiroko (Tokyo Univ.). Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A, No. 271, 1-37(Sept. 1967). (ISSP-A-271).

The superconducting transition temperatures and the critical fields have been measured by the magnetic method in a number of dilute superconducting La–Ce and La–Gd alloys to study the magnetic impurity effect. The concentration dependence of the transition temperature shows a deviation from the Born approximation value in the Abrikosov–Gor'kov theory and this deviation is dependent upon the sign of the s–f exchange integral of the impurity. This result is regarded as an evidence for the Kondo effect in superconductivity. Magnetic behaviors characteristic of the inhomogeneous type-II superconductors have been observed in pure La and the alloys. Comparison of the upper critical field data of the alloys with the theory of Fulde and Maki leads to a conclusion that the transport resistivity of La does not increase with increasing impurity concentration. The Ginzburg–Landau parameter of α-La at T_c is about 3.4 and decreases with increasing impurity concentration in accordance with Maki's theoretical prediction. (NSA of Japan)

9254 THEORY OF TWO-PHASE DOMAIN STRUCTURE IN SUPERCONDUCTORS AND FERROMAGNETS. Hubert, A. (Max-Planck-Inst. fuer Metallforschung, Stuttgart). Phys. Status Solidi, 24: 669-82(Dec. 1, 1967). (In German).

The domain structures in superconducting as well as in uniaxial ferromagnetic plates of infinite dimensions are investigated theoretically. It is characteristic of these domain structures that, in general, the domains split from the centers of the plates towards the surfaces in a complicated manner. Consequently, the domain width at the surface turns out to be much smaller than in the interior. This behavior is derived with the aid of an energy expression which essentially involves a steadily varying average domain width. Three parameters govern this behavior namely wall energy, surface energy of closure, and internal field energy. They depend upon the geometry and material of the sample and are given for both ferromagnetic and superconducting specimens. Knowing these parameters the calculations give the domain width at the center of the specimen as well as at the surface as a function of specimen thickness, temperature or the magnitude of an external field. (auth)

9255 OPTIMUM FORM OF A HIGHLY ELONGATED MAGNETIZING COIL OF SUPERCONDUCTING MATERIAL. Grinberg, G.; Bandere, Z. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 145-8(1967). (In Russian).

A calculation technique (used for determining the optimum form of a highly elongated magnetizing coil made of superconducting material) is applicable to designing magnetohydrodynamic devices. The coil has the form of two long bundles of superconductors, and the problem can be considered in the two-dimensional xy plane perpendicular to the bundles. Superconductivity breaks down above a critical field intensity (H_k), and the coil shape must be designed to insure the field (H) in the superconductors $H < H_k$. The problem is worked in relative field intensities ($\bar{H}$) with $\bar{H} = 1$ at the bundle surface. The current density was assumed constant and the calculations were carried out on a BESM-2 computer. Initially, the two coils form circular bundles with their centers on the x-axis at a distance of 1 radius to either side of the origin. The maximum of $\bar{H}$ at the origin is taken as 2. Then, for a specified $\bar{H}_k$ (six $\bar{H}_k$ from 1 to 1.9 are used), the isoline $\bar{H} = \bar{H}_k$ with a first approximation that of a parabola, is determined. The area of the bundle in which $\bar{H} > \bar{H}_k$ is eliminated and the coil radius is enlarged to give a new coil of equivalent area. Then a new isoline $\bar{H} = \bar{H}_k$ is computed. The process is repeated 5 to 15 times, producing the final curve accurate to 1%. (ATD)

9256 INTERACTION OF QUANTIZED VORTEX RINGS WITH QUANTIZED VORTEX LINES IN ROTATING He II. Schwarz, K. W. (Univ. of Chicago). Phys. Rev., 165: 323-34(Jan. 5, 1968).

The effect of steady rotation on a beam of charged vortex rings in He II has been investigated. The rotation-dependent changes in the beam are interpreted in terms of strong ring-line interactions experienced by a fraction of the rings, plus collective effects which are the same for all rings. An approximate calculation based on inviscid hydrodynamics and a uniform distribution of vortex lines yields fair agreement with the observed behavior. (auth)

9257 EXPERIMENTAL PROPERTIES OF LIQUID ^{3}He NEAR THE ABSOLUTE ZERO. Wheatley, J. C. (Univ. of California, San Diego). Contract AT(11-1)-34. Phys. Rev., 165: 304-9(Jan. 5, 1968). (UCSD-34P143-1).

Measurements of the coefficients of spin diffusion, thermal conductivity, and viscosity of liquid ^{3}He at very low temperatures and at pressures of 0.28 and 27.0 atm are discussed critically on the basis of a theory by Rice of transport in nearly ferromagnetic Fermi liquids. It is found that the temperature dependence of the thermal-conductivity coefficient is qualitatively similar to that predicted by Rice. However, neither the spin-diffusion coefficient nor the viscosity coefficient, as determined from ultrasonic attenuation measurements, is known precisely enough to give a good test of the Rice theory in the low-temperature limit. It is suggested on the basis of qualitative data that the anomalously low thermal boundary resistance between cerium magnesium nitrate and pure ^{3}He may result from the nearly persistent spin-fluctuation phenomenon. (auth)

9258 MOTION OF ROTATING SUPERFLUID HELIUM IN AN ANNULAR CHANNEL. Masson, B. (Philco Ford Corp., Newport Beach, Calif.); Tien, C. L. Phys. Rev., 165: 300-3 (Jan. 5, 1968).

A family of expressions is presented for the radial distribution of vortex lines in rotating helium II. This family is derived from asymptotic solutions to a differential equation proposed by Kemoklidze and Khalatnikov on the basis of the free-energy principle applied to a long, annular channel. The solutions are asymptotic in the sense that the quantum of circulation must be small compared to the circulation of a channel wall. The qualitative properties of the differential equation indicate that all solutions with positive vorticity and angular velocity of rotation are oscillatory. With increasing amplitude of oscillation, the solutions vary from the uniform vorticity distribution to distributions containing wide expanses free of vortex lines separated by narrow regions of high vortex-line density. This detailed analysis was necessary to determine whether a smooth transition could be achieved between a region of uniform vortex line density and a region of irrotational flow. The oscillatory solutions show that the answer is negative. Additionally, the oscillatory solutions are found to have high free energies, in agreement with the early analyses of London, of Landau and Lifshitz, and of Ginsburg. (auth)

9259 GROUND STATE OF SOLID ^{4}He AND ^{3}He. Hansen, Jean-Pierre; Levesque, Dominique (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Rev., 165: 293-9(Jan. 5, 1968).

A variational calculation of the curve of ground-state energy versus density for solid helium-3 and solid helium-4 absolute zero is presented, using a two-parameter "localized" Jastrow × Gaussian trial wave function. The energy expectation value is calculated by a Monte Carlo method taking advantage of the formal analogy between the quantum-variational integral and a classical canonical-ensemble configuration integral. Results are in good agreement with experiment. The solid-liquid phase transition for both ^{3}He and ^{4}He is predicted to take place at densities close to the experimental ones. The Monte Carlo method has also been used to test the validity of a variational calculation on a truncated cluster expansion of the energy expectation value due to Nosanow. (auth)

9260 SIZE-DEPENDENT TRANSPORT-COEFFICIENT EFFECTS IN FERMI LIQUIDS. Rice, Michael J. (Imperial Coll. of Science and Tech., London). Phys. Rev., 165: 288-92 (Jan. 5, 1968).

Landau's theory of a Fermi liquid is applied to investigate the size-limited transport coefficients of a Fermi liquid contained in a long narrow channel of diameter d small compared with the interquasiparticle mean free path λ. By characterizing the scattering of quasiparticles (QP) from the walls of the channel in a phenomenological way, expressions are obtained for the coefficients of spin diffusion, D, and of thermal conductivity, K. These expressions show, not unexpectedly, that D is a constant independent of T, giving a direct measure of the QP group velocity v_0, while K is proportional to T and coincides with the result that would be obtained if we had considered a noninteracting Fermi gas. Mass flow through the channel, which for $d \ll \lambda$ is not characteristic of viscous flow, is also considered. Under the action of an externally applied pressure gradient, it is found that mass is discharged at a temperature-independent rate G proportional to d^3: in the viscous regime ($d \gg \lambda$) G varies as d^4. The expression obtained for G is actually the Fermi-gas analog of the classical result originally obtained by Knudsen. The extension of the results to the regime $d \sim \lambda$ is briefly considered. As a consequence of competition between Knudsen flow and Poiseuille flow, a "Knudsen minimum" will appear in the temperature dependence of G. Some numerical estimates are made for liquid ^{3}He. (auth)

9261 STATISTICAL MECHANICS OF IDEAL FERMIONS IN A THIN FILM. Dewar, R. L.; Frankel, N. E. (Univ. of Melbourne, Parkville, Victoria). Phys. Rev., 165: 283-7 (Jan. 5, 1968).

Starting from the partition function for ideal fermions in a thin film with box boundary conditions, the influence of size effects on the specific heat is examined both numerically and analytically. For fairly thin films the specific heat is depressed at low temperatures and raised at high temperatures. In the very thin case, the behavior is that of a two-dimensional gas at low temperatures and that of a three-dimensional Boltzmann gas at high temperatures. The relevance to ^{3}He thin-film experiments is briefly discussed. (auth)

9262 CONCERNING THE SUPERCONDUCTIVITY OF V_3In. Alekseevskii, N. E.; Mikhailov, N. N. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 92-3 (Aug. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 584-5(Aug. 15, 1967).

The superconducting properties of V_3In are discussed for different methods of preparing the sample. (M.O.W.)

9263 INVESTIGATION OF DEGRADATION EFFECTS IN HIGH-FIELD SUPERCONDUCTORS BY MEANS OF PULSE MEASUREMENTS. Dietrich, I.; Weyl, R. (Forschungslaboratorium Muenchen der Siemens AG, Munich). Z. Angew. Phys., 24: 37-45(Dec. 1, 1967). (In German).

The state of an inhomogeneous current-carrying type-II superconductor in a magnetic field depends on the velocity and the succession for setting the field and current values. Details of the state of the superconductor are obtained by measurements of critical current and magnetization. Pulsed currents cause a decrease of the critical current by 10%. The effect of pulsed fields is influenced by the inhomogeneity of the material at low fields. High pulsed fields cause a degradation due to ac losses. Short sample measurements with current and field pulses give information about the coil behavior of the material. (auth)

9264 INFLUENCE OF ^{3}He ON THE MOBILITY OF POSITIVE IONS IN LIQUID HELIUM. Kovdrya, Yu. Z.; Esel'son, B. N. (Physical-Technical Inst. of Low Temperatures, Kharkov). JETP Lett. (USSR) (Engl. Transl.), 6: 90-2(Aug. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 581-4(Aug. 15, 1967).

The mobility of the positive ions was measured in a ^{3}He$-^4$He solution containing 3.9% ^{3}He, in the temperature interval from T_λ t 1.4°K. (M.O.W.)

9265 INTERACTION OF ELEMENTARY EXCITATIONS IN A MANY-BOSE PARTICLE SYSTEM. Nishiyama, Toshiyuki (Osaka Univ.). Sci. Rep., Coll. Gen. Educ., Osaka Univ., 15: 1-5(1966).

The role of the anharmonic terms that appear in the collective description of many-Bose-particle systems is considered. In previous studies of the interaction between phonons and individual particles in the scheme of the collective description, to estimate the effect of the interaction of this type, Feynman and Cohen considered a classical hydrodynamic effect and Miller and Pines considered the backflow effect of an impurity interacting weakly with liquid He. The interaction considered here involves the corresponding terms given by previous authors but is more comprehensive. The analysis goes a step further than the usual random phase approximation by introducing the canonical conjugate variable of the density fluctuation so that the interaction terms discarded in the author's previous analysis can be retained in the formulation. This canonical conjugate variable corresponds to the hydrodynamic velocity potential and can be expanded in terms of the creation and the annihilation operators of internal quanta. It is pointed out that a minimum in the energy spectrum appears even if the unperturbed spectrum increases monotonically. (BBB)

9266 ABSORPTION OF LONGITUDINAL ULTRASONIC WAVES IN TWO-ZONE SUPERCONDUCTING ALLOYS. Fal'ko,

I. I. (Kharkov State Univ.). Fiz. Metal. Metalloved., 24: 562-4(Sept. 1967). (In Russian).

The method of correlation of functions was used for determining the absorption of longitudinal ultrasonic waves in two-zone superconducting alloys. The second quantization concept of the Hamiltonian of the electron–phonon system with nonmagnetic impurities in a two-zone model is presented and analyzed. (R.V.J.)

9267 ENERGY DISSIPATION AND CLASSIFICATION OF THE ANNIHILATION MECHANISMS OF THE VORTEX LINES IN SUPERFLUID He IN ROTATION. Seiden, Joseph (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. A and B, 265: 285-7(Aug. 28, 1967). (In French).

Superfluid He in equilibrium in a cylindrical container in uniform rotation is considered. An attempt is made to elucidate the mechanisms of the relaxation of the rotation and to calculate the relaxation times from within the framework of the hydrodynamic approximations of the 2-fluid model. It is not then necessary to consider phenomena intervening at the level of the individual vortex lines. The energy dissipation in He in rotation is calculated. This will make it possible to enumerate and classify the various possible relaxation mechanisms. (J.S.R.)

9268 PROBLEM OF HIGH-TEMPERATURE AND SUPERFICIAL SUPERCONDUCTIVITY. Ginzburg, V. L.; Kirzhnits, D. A. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 176: 553-5(1967). (In Russian).

Continuing earlier studies on the creation of two-dimensional (superficial) superconductors with a high critical temperature ($T_c \gg 10$ to 20°K), an electron mechanism was investigated. It involved the spatial separation of the conductivity region from zones containing the polarizing nonmetallic medium responsible for the attraction between the conductivity electrons. The method used renders it easy to vary the parameters of the polarizing layer; it also results in a strong increase of the energy of the excitons, because the polarization of bound electrons in a metal is usually lower than in a "good" nonmetal. The variants investigated included a thin conducting fiber with a nonmetallic sheathing and a thin metallic film sandwiched between two nonmetallic layers. The thinnest possible film ($d = 10$ Å) is expected to exhibit only slight fluctuations; it is superior to the fiber variant because in the latter case the shielding of Coulomb replusion vanishes. The selected scheme is considered better suited to increase the value of T_c than the quasi-one-dimensional system. (TTT)

9269 ENERGY STORAGE AND EXTRACTION WITH SUPERCONDUCTING COILS. Anderson, Melvin Keith. Fayetteville, Ark., Univ. of Arkansas, 1967. 77p.

Thesis.

The storage and release of electrical energy from inductive storage systems using superconductors are dealt with. Inductors are known to have advantages over capacitors in every respect except ease of switching and the important property of storing the energy without appreciable loss. In the work described, it is shown that energy can be retained in the inductive storage system with low losses providing the conductor is operating in the superconducting state. The use of a second winding to alter the time constant of the energy release is analyzed, along with the effect of a coefficient of coupling of less than one on the efficiency of the system and the switching transients involved. The use of a capacitor to aid in the switching and to reduce the transients is investigated as is the effect of an initial charge on the capacitor. Various types of superconducting switches are investigated and a switch using the transition characteristics of a superconductor was developed having a current carrying capacity of approximately 30 amps and a switching time of less than 100 microseconds. Tests were made on a 10-joule storage coil utilizing a secondary winding that showed a reduction in the time constant of 300:1 and an energy coupled efficiency of approximately 98%. The superconducting switch performed satisfactorily in the system, providing excellent switching action and energy transfer. The test and theoretical considerations show excellent correlation and lead to optimum operating conditions. (Disser. Abstr.) (auth)

Plasma and Thermonuclear Physics

9270 (INR-P-846/XVIII/PP) PRZEGLAD PRAC BADAWCZYCH Z ZAKRESU FIZYKI GORACEJ PLAZMY WYKONANYCH W ZAKLADZIE FIZYKI I TECHNIKI PLAZMY IBJ. (Review of Research on Hot Plasma in the Plasma Physics and Technics Division). Gryzinski, Michal; Nowikowski, Jerzy; Sadowski, Marek; Suckewer, S. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 66p. (In Polish).

The main trends of research on hot plasma physics being carried out in the Institute of Nuclear Research at Swierk are discussed. The experimental arrangements as well as the diagnostic methods used and general technical problems are described. A review of theoretical studies is also given.

9271 (TID-24203) QUARTERLY PROGRESS REPORT NO. 87 [ON ELECTRONICS]. Zimmermann, H. J.; Harvey, G. G.; Mason, S. J. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Oct. 15, 1967. Contract DA-28-043-AMC-02536(E). 237p. Dep. CFSTI.

Separate abstracts were prepared for 6 of the sections. (M.O.W.)

For abstracts of individual sections see: 8409, 8856, 8994, 9188, 9307, and 9308.

Confinement and Heating of Plasma

Refer also to abstract 8330.

9272 (CEA-R-3197) ETUDE DE L'INJECTION ET DE LA CAPTURE TEMPORAIRE D'UN FAISCEAU DE PARTICULES CHARGEES DANS UNE CONFIGURATION MAGNETIQUE OUVERTE. OPTIMISATION DE LA CONFIGURATION. CAS DE LA SYMETRIE DE REVOLUTION: MACHINE A MIROIRS. (Injection and Temporary Capture of a Charged Particle Beam in an Open Magnetic Configuration. Optimization of the Configuration. Case of Cylindrical Symmetry: A Mirror Machine). Capdequi-Peyranere, Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1967. 126p. (In French). (EUR-3437). Dep.

Thesis. Submitted to Paris Univ., France.

A study has been made of a new method of transverse injection of charged particles into a magnetic mirror configuration. This injection scheme permits the penetration and temporary capture by nonadiabatic effect of a particle beam of approximately 1-cm^2 cross section. A theoretical study of the injection and capture is made in the approximation that space charge is negligible. The original programs for IBM 7094 computer calculations are described; these programs were used to obtain an optimization of the configuration. The results of a statistical numerical study of the optimum configuration are then given. This study indicates that, if the energy of the particles of the beam is about 1% greater than a minimum penetration energy, the entire beam can be captured with an average capture length of 100 meters (50 reflections between the two mirrors). If the energy is about 4% greater than the minimum penetration energy, the capture length is reduced to 40 meters. The distribution of energy transverse and longitudinal with the magnetic field for the population of captured particles was studied. For the cases of injected molecular hydrogen ions or heavy CH_4^+ ions, a study was made of the capture time of protons resulting from the dissociation of the ions by collisions with the neutral gas. Finally, a model experiment using electrons designed to provide an experimental verification of the capture of the primary beam is described. (auth)

9273 (N-67-22920) VERKSAMHETSRAPPORT FOR AR 1965. (Work Report, 1965). Alfven, H.; Herlofson, N. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Feb. 10, 1966. 16p. (In Swedish). CFSTI.

The research activity has been directed towards: plasma confinement and fusion reactions in the magnetic field of a ring current; study of high pressure discharge and ionizing current wave in coaxial plasma gun; experiments with plasma entering a magnetic dipole field and plasma in an inhomogeneous magnetic field; electric fields in collisionless plasma in a mirror field; study of electric arcs at atmospheric pressure and of double layers in a mercury discharge; theory of circuit interruption in a plasma; development of electron accelerators; cosmic radiation, cosmology, and cosmogony as well as physics of the magnetosphere and ionosphere. (STAR)

9274 (SIT-2582-25) EXPERIMENTAL INVESTIGATION OF CUSPED CONTAINMENT GEOMETRIES, CHALICE. Annual Report, 1966–1967. Yevick, George J. (Stevens Inst. of Tech., Hoboken, N. J.). Contract AT(30-1)-2582. 170p. Dep. CFSTI.

Research developments during this period are reported: (1) experimental results and their interpretation, (2) plasma dynamics, (3) Mach–Zehnder interferometer, (4) bremsstrahlung, (5) fast scintillator, (6) low-temperature measurement, (7) preheater, (8) θ-pinch bank, (9) cusp bank, (10) plasma chamber, (11) coil design, (12) snow-plow model shock-front for fast pinches, and (13) direct correlation function in space and time. (M.O.W.)

9275 (SIT-2582-26) HISTORICAL SURVEY OF PROJECT CHALICE. EXPERIMENTAL INVESTIGATION OF CUSPED CONTAINMENT GEOMETRIES, CHALICE. Yevick, George J. (Stevens Inst. of Tech., Hoboken, N. J.). [1967]. Contract AT(30-1)-2582. 34p. Dep. CFSTI.

Review type discussions are presented on the following: (1)

original Chalice proposal, (2) present scheme of Chalice, (3) ring Chalice, (4) development of project Chalice, (5) unsolved problems, (6) theoretical work, and (7) future work. (M.O.W.)

9276 (MATT-Trans-44) INTERACTION OF A BEAM OF RUNAWAY ELECTRONS WITH THE PLASMA IN A STELLARATOR. Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; Nikolaev, R. M.; Potapenko, V. A.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Princeton Univ., Plasma Physics Lab., N. J., from report FTI-284/P-098. 15p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The experiment is described and current oscillograms are given. (M.O.W.)

9277 (MATT-Trans-45) CLOSED MAGNETIC TRAP WITH A HELICAL FIELD "SIRIUS." Biryukov, O. V.; Burchenko, P. Ya.; Vasilenko, V. T.; Volkov, E. D.; Georgievskii, A. V.; Loginov, A. S.; Nikoleav, R. M.; Sashenko, Yu. V.; Suprunenko, V. A.; Tolok, V. T. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Princeton Univ., Plasma Physics Lab., N. J., from a Russian report. 19p. Dep. CRSTI. JCL $1.60 fs, $0.80 mf.

A brief description of the Sirius stellarator is given. The characteristics of the individual units of the trap and the arrangement used in generating and heating the plasma are given. (M.O.W.)

9278 PERSPECTIVES OF THE RESEARCH ON THE PROBLEM OF CONTROLLED NUCLEAR SYNTHESIS. Artsimovich, L. A. Usp. Fiz. Nauk, 91: 365-79(Mar. 1967). (In Russian).

Three main directions of research are noted. The first is based on the use of open magnetic traps in which the plasma is retained due to reflection of charged particles from regions of a strong magnetic field. The second is based on the use of annular plasma configurations included within closed magnetic systems. In these two cases the plasma retention time exceeds by many orders of magnitude the time necessary for the particle to transverse the magnetic trap. The magnetic fields are either constant or vary slowly with time. The third field of research is the rapid compression of a plasma by a magnetic field ("fast pinch"). It is generally acknowledged that flute instabilities can be eliminated by providing an open magnetic trap in which the magnetic field rises on all sides of the region occupied by the plasma. However, other types of kinetic instabilities due to ion oscillations still plague the investigator. An analysis of the energy balance for systems with open magnetic traps shows that the following condition must be met: $\eta_m > 1.1 - (0.64/\alpha)$. Here η_m is the efficiency of recovery of energy escaping through the magnetic mirrors, and α indicates how many times the particle losses via the magnetic force lines under actual conditions exceed the value for the ideal case with a stable plasma. With $\alpha = 2$ the recovery efficiency should be about 80%, and with $\alpha = 3$ it should exceed 90%. Thus if the energy losses along the force lines exceeds by a factor of 3 or more the value corresponding to the usual mechanism of paired Coulomb collisions, thermonuclear reactions with excess energy yield become impossible. A similar analysis of closed magnetic trap systems shows that the condition $na^3H_z^2 > 10^{31}$ should be fulfilled. With $n = 10^{15}$ and $H = 10^5$ this condition will be observed if the radius of the transverse cross section of the plasma ring exceeds ~1 meter. Thus it seems that closed magnetic traps such as Tokamak at present are more likely to achieve controlled nuclear fusion than the open magnetic traps such as Ogra and DCX, but development should continue on a broad front. (TTT)

9279 PLASMA HEATING BY THE FAST HYDROMAGNETIC WAVE. Chung, K.; Rothman, M. A. (Princeton Univ., N. J.). Phys. Fluids, 10: 2634-41(Dec. 1967).

The fast (right-handed) hydromagnetic wave is generated by a Stix coil installed on the Model C stellarator. Maximum wave generation and heating occurs, as expected, under conditions such that the wavelength of the propagating wave equals the wavelength of the coil structure. Measurements of diamagnetic pressure determine the efficiency for conversion of rf power into thermal energy. Theoretical calculations of heating rates show that plasma resistivity and Landau damping are insufficient to account for the observed heating rates if only the body wave is considered. Introduction of surface waves associated with finite electron mass results in increased E_z fields which enhance the heating rate. (auth)

9280 SINGLE PARTICLE MOTION IN TOROIDAL STELLARATOR FIELDS. Gibson, A.; Taylor, J. B. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 10: 2653-9(Dec. 1967).

The discussion of the motion of single particles in stellarators is simplified by identifying three distinct groups of particles. The drift equations are used to treat these groups by analytical and numerical methods. It is shown that, unlike an axisymmetric system, the region of a stellarator with surfaces closed about a magnetic axis need not form a perfect trap. In fact, unless the toroidal curvature is very small, particles in one of the groups, those mirrored between maxima in a single period of the helical field, will drift out beyond the separatrix no matter how large the magnetic field strength. (auth)

9281 ANOMALOUS ELECTRON HEATING IN AN ADIABATIC COMPRESSION EXPERIMENT. de Kluiver, H.; Kawamura, T. (Univ. of California, Berkeley). Phys. Fluids, 10: 2715-17(Dec. 1967).

Final electron temperature increases considerably in an adiabatic compression when oscillating electric fields are applied at the plasma shortly after injection. The anomalous resistance is consistent with the growth rate of an electron two-stream instability. (auth)

Diagnostics of Plasma

Refer also to abstracts 9038, 9188, and 9427.

9282 MEASUREMENT OF THE DENSITY AND TEMPERATURE FLUCTUATION OF NEUTRAL PARTICLES IN A DIFUSION PLASMA BY OPTICAL SPECTROSCOPY. Jacquot, Claude; Stevenin, Pierre (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 893-5(Oct. 23, 1967). (In French).

The association of an image converter with a Fabry–Perot optical interferometer constitutes an instrument for the measurement of the density and temperature fluctuations of a plasma. The use of such a system in the study of these fluctuations and more particularly of the low-frequency instabilities of the plasma is described. (tr-auth)

9283 METHOD OF MEASUREMENT OF THE ELECTRON DENSITY OF A PLASMA WITH A GAS LASER IN A HOMODYNE MOUNTING AND UTILIZING THE ROTARY DISPERSION OF THE ELECTRONS. Rostas, Francois (Compagnie Generale d'Electricite, Marcoussis, France). Compt. Rend., Ser. A and B, 265: 904-6(Oct. 23, 1967). (In French).

A new method permitting the measurement of the electron density of a magnetoplasma is described. It is placed in the optical cavity of a gas laser which has the effect of doubling the oscillation modes. The limit sensitivity would be typically 5×10^{11} electrons/cm^2 of the beam for a magnetic field of 10,000 Oe. (tr-auth)

9284 GENERALIZATION OF THE SYMMETRIC THREE-PROBE METHOD TO THE CASE OF PLASMAS HAVING HIGH POTENTIAL AND DENSITY GRADIENTS. Bacri, Jean (Faculte des Sciences, Toulouse). Compt. Rend., Ser. A and B, 265: 911-13(Oct. 23, 1967). (In French).

When it is impossible to place three probes on the same equipotential surface, which is the case in electrodeless high-frequency discharges, the classical theory leads to erroneous results. The theory of Chen and Sekiguchi is adapted to plasmas where spatial variations in density and potential exist. A new method for the measurement of "zero currents," more precise than preceding methods, is proposed. (tr-auth)

9285 ANTENNA IMPEDANCE IN A WARM PLASMA. Carlin, James Walter. Urbana, Ill., Univ. of Illinois, 1967. 100p.

Thesis.

Expressions have been derived for the impedance of biconical and cylindrical dipoles in a warm isotropic plasma. A linearized hydrodynamic description was used as a plasma model. Collisions were neglected throughout as they should modify only the quantitative effects and not the qualitative effects of "plasma" waves on impedance. In determining the impedance of a cylindrical dipole in intimate contact with a plasma, the effect of the induced acoustic sources (force and fluid flux distributions) on the antenna surface must be accounted for in addition to the effects of the induced current distribution. This was accomplished by derivation of a suitable stationary formula for impedance which accounts for the effects of all the induced sources. The main advantage of this type of formulation is that it is only necessary to know the functional form of the induced sources and not their relative magnitudes in order to obtain impedance values. This, of course, is an inherent property of the variational formulation. In general, the effect of the acoustic sources on impedance was found to be quite small, except in certain instances. In the treatment of a biconical dipole the antenna was assumed to be encased in an insulating dielectric which is immersed in a plasma. For this model an exact expression was derived for the terminal admittance for very thin antennas. For wide angle dipoles a variational expression, which depends on the aperture tangential electric field, was derived. The admittance was found to be strongly dependent on the ratio of the velocity of light in free space to the acoustic velocity in the plasma. Compressibility effects seem to be quite significant if the acoustical "phase length" of the antenna is approximately 20 or less. The presence of an ion sheath decreased the power radiated in the "plasma" wave. (Disser. Abstr.)

9286 POSSIBILITIES OF SUPERSONIC PLASMA FLOW INVESTIGATION BY MEANS OF A PILOT TUBE COMBINED WITH AN ELECTRIC PROBE. Kalashnikov, V. K.; Kalikhman, L. E. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 59-66 (1967). (In Russian).

The possibility of the use of total-pressure tubes for the diagnosis of plasma flow was examined. Solutions of the equations of pulse transfer and energy of the components of a dual-temperature plasma in the absence of a magnetic field revealed some relations between measured parameters and the plasma parameters in front of the collision wave. The expediency of the use of the total-pressure tubes in conjunction with electrostatic probes was noted. The interpretation of the results of the measurement of the tube in the case of plasma flow in a magnetic field was examined. On the basis of the Gyugon relation and Bernoulli's equation, a simple approximation method was proposed for the determination of the flow Mach number with respect to the known induction of the magnetic field, static pressure of the nondisturbing flow, and the measured pressure of the frictional action. (tr-auth)

9287 INVESTIGATION OF IONIZED ARGON BEHIND SHOCK WAVES BY INTERFEROMETRIC METHODS. Zaitsev, S. G.; Lazareva, E. V.; Chebotareva, E. I. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 86-90(1967). (In Russian).

The methods of interferometry, combined with spectrography, used for the determination of the electron concentration N_e ($10^{15} < N_e < 10^{18}$ cm^{-3}) in gases ionized by shock waves, are described. The total density of the atomic and ion components were determined simultaneously with N_e. The density and degree of ionization were determined for shock waves with Mach number from 9 to 12 propagating in argon. (tr-auth)

9288 CHARACTERISTICS OF A TOROIDAL RESONATOR FOR PLASMA DIAGNOSTICS. Sicha, M.; Cloutier, G. G.; Bolton, R. (Univ. of Montreal). Can. J. Phys., 45: 3979-90 (Dec. 1967).

An experimental investigation of the electric-field configuration in a toroidal resonator has been carried out by measuring the shift of the resonant frequency when a small dielectric sphere is introduced in the resonator. The good agreement between the experimental and the theoretical results shows that the assumptions concerning the electromagnetic-field configuration are correct and the method can be used in measuring the electrical conductivity of a plasma. (auth) (CANADA)

9289 PLASMA DIAGNOSTICS BY LITHIUM EMISSION SPECTRUM IN ARC DISCHARGE. Grechikhin, L. I.; Tyunina, E. S. (Inst. of Physics, Minsk). Teplofiz. Vys. Temp., 5: 764-8(Sept.-Oct. 1967). (In Russian).

It was shown that with respect to the broadening of the spectral lines of lithium, reliable measurements can be obtained of the concentration of charged particles only by its accurate use or by some theory of the broadening of the spectral lines. The measurements of the concentration of charged particles by broadening of the spectral lines and by intensity of forbidden transitions agree within the limits of error. In heterogeneous sources, spectral lines with the highest Stark constant gives the smallest value of the concentration of charged particles, which is connected with the different distribution of the maximum intensities of lithium centers along the source radius. A method for the measurement of the distribution of the concentration of charged particles along the radius of the axial symmetric heterogeneous source was proposed. The method used some sets of spectral lines having different values of the Stark constant, as examples with equal excitation potentials. (tr-auth)

9290 INSTALLATION OF THE "Q-MACHINE" TYPE AND INVESTIGATION OF POTENTIAL NOISE OF POTASSIUM PLASMAS. Rakhimbabaev, Ya. R.; Rusanov, V. D.; Titov, A. V. (Inst. of Physics, Minsk). Teplofiz. Vys. Temp., 5: 756-63(Sept.-Oct. 1967). (In Russian).

The installation and diagnostic apparatus for investigation of cesium and potassium plasmas are described. Highly ionized stationary columns of plasma with diameter of 3 cm and length of 105 cm had densities on the axis of 5×10^8 to 5×10^{11} cm^{-3}. The magnetic field could be varied from 0 to 4.5 kOe. The results of the study of the potential noise in potassium plasma are reported. (tr-auth)

9291 MEASUREMENTS OF ARGON SHOCK LAYER ELECTRON DENSITIES. Oettinger, Peter E. (Stanford Univ., Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 150-1 (Jan. 1968).

Dual-wavelength interferometry is used to measure the electron densities surrounding a cylinder–plate, at zero angle of attack, immersed within a supersonic shock-tube argon plasma. (M.O.W.)

9292 TEMPERATURE MEASUREMENT OF AN ALKALI METAL-SEEDED PLASMA IN AN ELECTRIC FIELD. Chu, T. K.; Gottschlich, Chad F. (Univ. of Pennsylvania, Philadelphia). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 114-19(Jan. 1968).

Additional measurements have been made of the electrical conductivity of a sodium–potassium-seeded, argon plasma in the presence of an electric field. The electron temperature is measured by a spectroscopic method, the gas temperature by a thermocouple, and the conductivity is deduced from electric field and current density measurements. The conductivity measurements are in good agreement with other published data. The measurements of the electron temperature lend support to the belief that a unique local value of the electron temperature exists. (auth)

9293 STUDY OF SHOCK WAVES IN A NONEQUILIBRIUM PLASMA. Christiansen, Walter H. (Jet Propulsion Lab., Pasadena, Calif.). Phys. Fluids, 10: 2586-95(Dec. 1967).

Probe and recombination-radiation spectrum measurements were used to measure the electron number density and temperature profiles in front of a flat disc in a supersonic seeded-gas plasma. The region of interest extended several body diameters upstream of the disc and through the shock wave. The experiment covered a free stream electron density range of 4×10^{11} to 1.6×10^{12} cm^{-3} and an electron temperature range of 0.06 to 0.1 eV. The region of reduced luminosity upstream of the shock wave is shown to be associated with electron heating at constant electron density. The electron thermal conductivity is derived from measurements in the upstream region and gives reasonable agreement with the Spitzer formula. Measurements are made of the electron temperature change across the heavy-particle shock wave and of the overall electron temperature ratio across the entire process. It is shown that the overall electron-temperature ratio could not be predicted on the basis of an adiabatic one-dimensional flow process in this experiment. (auth)

9294 PLASMA WIND TUNNEL STUDIES OF COLLISION-FREE FLOWS AND SHOCKS. Pugh, E.; Patrick, R. (Avco Everett Research Lab., Everett, Mass.). Phys. Fluids, 10: 2579-85(Dec. 1967).

A plasma wind tunnel has been constructed and the super-Alfvénic flow over a magnetic obstacle studied. The wind tunnel produces a steady (10^{-3} sec) flow of high-enthalpy (~100 eV), high-density (10^{14}) plasma. The flow of this high-conductivity plasma has been studied using magnetic field probes. The interface and shock wave produced in front of a magnetic obstacle in the flow have been studied. The shock wave is shown to satisfy the usual magnetohydrodynamic Rankine–Hugoniot relations. (auth)

9295 APPLICATION OF A MICROWAVE TECHNIQUE TO THE MEASUREMENT OF ELECTRON DENSITY AND IONIZATION TIME. Lederman, Samuel; Dawson, Edward F. (Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.). Phys. Fluids, 10: 2570-8(Dec. 1967).

The measurement of ionization rates, electron density, and ionization time in thermally ionized gases, by means of a microwave technique, is discussed. The technique used in this work utilizes a so-called "end-wall" microwave resonant cavity. It is essentially a microwave cavity operated in the TE_{011} mode with a plasma forming one end wall. Since the resonant frequency of such a cavity is a function of the axial length of the cavity, a variable density plasma with its corresponding variable conductivity is utilized to tune the cavity to different resonant frequencies. It is shown that by applying two frequencies to the cavity separated from each other by a known Δf, which is small compared to the resonant frequency of the closed cavity, a simple method is arrived at to measure electron density, ionization rate, and ionization time. (auth)

9296 CORPUSCULAR DIAGNOSTICS OF HOT PLASMA (REVIEW). Afrosimov, V. V.; Gladkovskii, I. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 1557-97 (Sept. 1967). (In Russian).

A comprehensive review, based on over 100 Soviet sources and 74 Western sources, is made of the present state of the art in the corpuscular diagnostics of hot plasma. The corpuscular method is considered the most direct means of investigation since it can utilize particles (ions, electrons, atoms) which are part of the plasma or are introduced from outside, and its application does not depend on the physical condition of the plasma object. The results obtained by such methods are easy to interpret since no modeling is necessary. The review is limited to summary discussions of various methods of corpuscular diagnostics. Classification of the methods is made on the basis of the experimental techniques used. The main areas of applications of each method are indicated. The authors conclude that the corpuscular method is already a valuable instrument for plasma investigations and can be used in practically every existing plasma machine. (ATD)

9297 SEMIEMPIRICAL FORMULAS FOR THE ELECTRON-IMPACT WIDTHS AND SHIFTS OF ISOLATED ION LINES IN PLASMAS. Griem, Hans R. (Univ. of Maryland, College Park). Phys. Rev., 165: 258-66(Jan. 5, 1968).

Using the Bethe–Born approximation for excitation and deexcitation cross sections with semiempirical effective Gaunt factors as proposed by Van Regemorter and Seaton, and extrapolating to below threshold energies, an "optical" cross section is obtained which agrees on the average to within a factor of 1.5 with measured Stark widths for ratios of initial electron energies to threshold energies from about 0.5 to 50. At low values of this ratio, inelastic collisions causing allowed dipole transitions are almost negligible, indicating that most of the broadening is then due to elastic collisions and, probably to a lesser extent, also to superelastic collisions and inelastic collisions involving higher multipole interactions. Comparison of this semiempirical cross section with quasiclassical estimates shows that the dependence on two parameters (namely, the Coulomb parameter and the relative size of the dipole matrix elements) not accounted for in the semiempirical effective Gaunt factors is generally weak in line-broadening applications. Line shifts are estimated from the widths using a dispersion relation, and from an expression valid for large perturber energies. Over the whole energy range considered, the ratio of the shift d of the maximum to the (half) half width w is found to vary between about 0.7 and 1.4 for lines where there is no cancellation between contributions to the shift from various levels. For other lines this ratio is smaller, in reasonable agreement with experiments. The measurements are also consistent (though not conclusively) with the existence of an additional blue shift (plasma polarization shift) corresponding typically to $\Delta(d/w) \approx 0.15$. (auth)

9298 TEMPERATURE OF ELECTRONS AND HEAVY PARTICLES IN AN ARC WITH AXIAL FLOW OF ARGON. Gol'dfarb, V. M.; Uzdenov, A. M. (Leningrad Pedagogical Inst.). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 81-4(Feb. 1967). (In Russian).

The temperature in an arc measured by the temperature balance method and by the spectroscopic method do not agree. This disagreement is explained by the separation of the gas stream into a preaxial conducting region and a cold region. The two-step or more complex model makes it possible to calculate more accurately the arc properties than the simplest model which fails to account for the radial exchanges of the stream parameters. In such models it is assumed that plasma equilibrium, i.e., the electronic temperature T_e and the heavy particle temperature T are identical. However, the validity of this assumption has been verified experimentally only for those arcs which operate under conditions of free convection. The intense radial heat transport from this column of gas enveloped arc may lead to a decrease in T in comparison with T_e, and therefore the equality $T = T_e$ under these conditions is not apparent. In the present article independent measurements of T_e and T distributions were made on different cross sections of the arc discharge in order to find the relationship between these quantities. It was found that under all operational conditions T_e is greater than T, and this difference decreases with an increase in flow rate, decrease of the gas flow rate, and at distances further removed from the cathode of the plasmatron or from the axis of the arc. For each flow rate and gas flow rate the leveling of T_e and T occurs at some definite distance from the cathode. The results indicate that the discrepancy between the mean mass and electronic temperatures is determined not only by the presence of an unheated layer of gas but also as a result of the temperature difference between the gas and electrons along the whole cross section of the flow. (ATD)

9299 OPTICAL MEASUREMENT OF PLASMA DENSITIES IN A LARGE THETA-PINCH. McLean, E. A. (Naval Research Lab., Washington, D. C.). Appl. Opt., 6: 2121-4(Dec. 1967).

A technique is described to measure the electron density distribution of a high-temperature plasma, produced in a theta pinch, by observing the bremsstrahlung continuum radiation emitted. Streak cameras record simultaneously the visible light emitted at three axial positions. The photographic film is calibrated using a short-duration flash and a step filter, and densitometer scans give the relative intensities. The data are placed on an absolute basis with a calibrated monochromator. An Abel inversion of the data gives the radial intensity distribution, from which the electron density distribution may be calculated. Estimated accuracy of the density measurement is ±25%. (auth)

9300 PLASMA SPECTROSCOPY IN THE VACUUM ULTRAVIOLET AND SOFT X-RAY REGIONS. Elton, R. C.; Roth, N. V. (Naval Research Lab., Washington, D. C.). Appl. Opt., 6: 2071-8(Dec. 1967).

Techniques involved in the spectroscopy of pulsed sources in the vacuum ultraviolet and soft x-ray spectral regions are described in connection with recent developments in a high-temperature plasma physics program. The time-integrated spectrum between 15 and 1800 Å was analyzed using semiautomatic computer techniques for the grazing-incidence portion. Time-resolved absolute-intensity measurements of O III to O VIII ion lines are described as related to recent results on energy losses and impurity content, as well as excitation rate coefficients. Broadband measurements of x-ray continuum radiation with four simultaneous detection channels are also described, and typical results of computer calculations necessary for the interpretation in terms of electron temperature are included. (auth)

9301 STARK EXPANSION OF SPECTRAL LINES IN PLASMA IN STRONG ELECTRIC AND MAGNETIC FIELDS. Aleksin, V. F.; Fesenko, V. M. Radiotekh. Elektron., 12: 1624-30(Sept. 1967). (In Russian).

The Stark expansion effect of spectral lines in a high-temperature plasma in strong magnetic and electric fields was investigated. Mathematical formulas were obtained for events in steady-state and quasi-linear approximations. (tr-auth)

Kinetics of Plasma

Refer also to abstracts 8415, 9035, 9045, and 9150.

9302 (CLM-R-74) DESTRUCTION OF THE SHARP TRANSITION IN COLLISIONLESS SHOCK WAVES DUE TO HIGH β EFFECTS. Iiyoshi, A. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Aug. 1967. 10p. Dep. CFSTI. UK 1s. 9d.

The magnetosonic wave propagating almost perpendicular to the magnetic field is discussed in connection with the destruction of a sharp shock transition at high Alfvén Mach number ($M_A \gtrsim 3$) observed in collisionless shock experiments. It is proposed that at a critical Alfvén Mach number ($M_A = 3 \sim 4$) the values of β and the local magnetosonic Mach number behind the shock become nearly unity. These effects would allow the waves to propagate upstream forming another quasi-shock wave whose dissipative mechanism would be mainly damping of the magnetosonic waves. (auth)

9303 (IPP-1/72) NUMERICAL INVESTIGATION OF COLLISIONLESS COMPRESSION OF A PLASMA WITH ANOMALOUS FRICTION. Chodura, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1967. 28p. Dep.

The effect of friction on the time development of the profile of a strong compression pulse propagating perpendicular to a magnetic field is studied in cylindrical geometry using two-fluid equations. The friction term roughly describes the action of a two-stream instability by limiting the electron velocity to a critical value. Depending on this critical value and a parameter δ (ratio of electron inertial skin depth to initial plasma radius) the steepening process during compression may or may not lead to a discontinuity. The time history of the profiles and conditions for the occurrence of the discontinuity are investigated for the case that no magnetic field is initially present in the plasma. (auth)

9304 (N-67-22496) ON THE PARTICLE, MOMENTUM, AND HEAT BALANCE OF A MAGNETIZED PLASMA. No. 66-17. Lehnert, Bo (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Oct. 4, 1966. 101p. CFSTI.

Investigations of the particle, momentum, and heat balance of a partially ionized plasma are extended, and results applied to rotating and nonrotating fully ionized plasmas which are confined by a poloidal magnetic field and surrounded by boundary regions containing neutral gas. The heat balance of nonrotating high-density plasma is estimated for a partially open-end system subjected to Ohmic heating and magnetic pumping. Some simple methods of measuring the confining properties of a magnetic configuration and of the temperature and its decay are suggested. (STAR)

9305 (N-67-22498) SEPARATION OF MATTER AND ANTIMATTER. No. 66-18. Alfven, H. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Dec. 1966. 17p. CFSTI.

Some processes during the metagalactic development are discussed that could produce a separation into matter and antimatter in a homogeneous ambiplasma supposed to be collision-free. (STAR)

9306 (ORO-3647-1) OBLIQUE COLLISIONLESS SHOCKS AND PLASMA TURBULENCE. Progress Report No. 1. (Texas Univ., Austin. Center for Plasma Physics and Thermonuclear Research). Jan. 1968. Contract AT(40-1)-3647. 16p. Dep. CFSTI.

The apparatus and results to date are briefly described. (M.O.W.)

9307 (TID-24203, pp 53-71) PLASMA PHYSICS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Research is reported on: (1) radiofrequency absorption in plasmas, (2) bremsstrahlung from a highly turbulent plasma at harmonics of the plasma frequency, and (3) diffusion waves. (M.O.W.)

9308 (TID-24203, pp 73-134) PLASMAS AND CONTROLLED NUCLEAR FUSION. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Research is reported on: (1) system C, (2) computer models of the beam–plasma interaction, (3) thin electron beam interactions with ions in a plasma-filled waveguide, (4) alternative stability analyses, (5) dynamics of the plasma boundary, (6) interactions of a spiraling electron beam with a plasma, (7) low-field microwave emission from contactless indium antimonide samples, (8) and hollow-cathode arc plasma. (M.O.W.)

9309 (NP-tr-1606) ON THE CORRELATION FUNCTIONS AND THE PRESSURE OF A NONISOTHERMAL PLASMA. Medvedev, E. S. Translated for Culham Lab., Abingdon, Eng., from Phys. Lett., 24A: 559-60(May 8, 1967). 3p. (CTO-412). Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Bogolyubov's equations are used to calculate the correlation functions for $N_e = N_i$ plasma. (M.O.W.)

9310 PERFORMANCE OF A HIGH-FREQUENCY FIELD ACCELERATOR WITH LASER PREIONIZATION. Briand, Paul; Consoli, Terenzio; Mourier, Georges; Slama, Lucien; Vial, Pierre (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 900-3(Oct. 23, 1967). (In French).

The experimental verification of the effect of high initial densities (created by laser ionization) on the characteristics of accelerated plasma bursts is described. (tr-auth)

9311 ABSORPTION OF ELECTROMAGNETIC ENERGY BY PLASMA IN HIGH-FREQUENCY FIELD ACCELERATORS. Brambilla, Marco; Canobbio, Ernesto (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 896-9 (Oct. 23, 1967). (In French).

The energy absorbed by the plasma in a mixed structure (static magnetic field + high frequency field) was given as a function of the density of the injected plasma. (tr-auth)

9312 STUDIES OF MOVING STRIATIONS BY MICROWAVE METHOD. Zaitsev, A. A.; Leonov, G. S. Zh. Prikl. Mekh. Tekh. Fiz., No. 2, 129-31(Mar.-Apr. 1967). (In Russian).

The electron density n_e in a traveling wave of a He, Ne, or Ar discharge was measured by a microwave method. As a result of the movement of the traveling wave, the high-frequency power transmitted through a fixed spot along the discharge changed in a periodic fashion. This change was registered by means of an oscillograph. The transmission coefficient K is a function of the electron density n_e. Three sealed tubes were used in the experiments. One tube was filled with He at a pressure of 0.7 mm, and the others with Ne and Ar at pressures of 0.5 mm Hg std. The measurements were carried out in the 10 cm range at low power. It was shown that the variation in light output S along the positive gas column coincided with the variation in electron density n_e. (TTT)

9313 THEORY OF SKIN EFFECT IN AN ELECTRODE DISCHARGE. Ryutov, D. D. JETP Lett. (USSR) (Engl. Transl.), 6: 187-90(Sept. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 704-7(Sept. 15, 1967).

The problem of skin flow of a high-frequency current is investigated for the case when the thickness of the skin layer is small compared with the transverse dimension of the plasma column and the plasma boundary can be regarded as plane. It is assumed that the electrodes are parallel to each other and perpendicular to the plasma boundary. It is concluded that with sufficiently small distance between electrodes the thickness of the skin layer is much larger than the value calculated by the semibounded plasma model used successfully for electrodeless discharges. (A.G.W.)

9314 HAMILTONIAN FORM AND THE RADIATION FIELD IN MAGNETO-PLASMA. Ho, Tso-jen (National Central Univ., Taiwan). Bull. Inst. Geophys., Nat. Cent. Univ., No. 1, 51-62 (June 1967).

After Eidman and Kolomenskii, the relativistic effect is included to develop the Hamiltonian form for calculating the energy radiated by the electric field in the anisotropic and dispersive magnetoplasma which is characterized by a complex dielectric tensor $\overleftrightarrow{\epsilon}$ with Hermitian property. The result is to obtain some features different from others and to demonstrate the unusual properties of the radiation from the study of the formulas for Cherenkov and cyclotron radiations. (auth)

9315 PROTON MOTION IN THE FIELD OF ALFVEN WAVES. Kovalenko, V. S. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 110-16(1967). (In Russian).

With an aim at explaining the mechanism whereby charged particles such as protons escape from the geomagnetic traps in outer space, the author solves the equations of motion of a proton under the influence of perturbations of the magnetic field in the form of hydromagnetic waves. Unlike earlier investigations, account is taken of the total spectrum of the hydromagnetic waves and, making use of the random character of the phases of the individual spectral components, the statistical parameters of the motion of the proton in the field of Alfvén waves is determined. The maximum pitch angle at which the proton interacts with the wave is determined from the resonance conditions. Expressions are obtained for the relative change of the magnetic moment in a given time interval and for the characteristic time of variation of the magnetic moment, defined as the characteristic time of the phase variation. Equations are then derived for the mean values of the proton velocity and of their second-order moments, as well as the mean values of the pitch angle and their second-order moment. It is shown that the main result of the interaction between the protons and the hydromagnetic waves is their diffusion with respect to pitch angles, which can lead to escape of the protons from the trap. The results can be used to derive an equation for the distribution function of the protons. (ATD)

9316 CONCERNING ONE PHENOMENON OCCURRING IN A HIGH-FREQUENCY DISCHARGE IN A GAS. Anashkin, G. A. (Moscow Evening Metallurgic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 131-4(1967). (In Russian).

An experimental verification of the diffusion theory of high-frequency discharge in different gases is reported. The tests were made in a coaxial resonator in a wide range of frequencies in the decimeter band, for inert gases, and under conditions of continuous generation. The idea of the test was to produce an electric-field antinode in the center of the coaxial resonator, and to plot the breakdown voltage as a function of the pressure. The results show that the different rates of diffusion of the electrons and the ions produce in the gas a space charge that slows down the breakdown considerably and thus greatly increases the breakdown field intensity over a considerable range of frequencies. This can take place not only under the conditions of the inhomogeneous field of a coaxial waveguide, but also in the case of a homogeneous field, but then the region of increased breakdown strength shifts from the decimeter band to the meter band. (ATD)

9317 EFFECT OF COLLISIONS ON HYDROMAGNETIC WAVES. Malik, S. K.; Trehan, S. K. (Univ. of Delhi). Nuovo Cim. (10), 52A: 1071-85(Dec. 21, 1967).

The effect of collisions on the theory of low-frequency wave propagation in a low-β plasma is taken into account by using the moment equations derived by Kaufman. The general dispersion relation is obtained and examined in the various limiting cases. We find that the inclusion of Hall current and finite ion Larmor radius makes the medium dispersive. When propagation is along the field lines, the damping of the acoustic mode is due to viscosity, electrical conductivity, thermal conductivity and thermoelectric coefficients, while the damping of the hydromagnetic mode is due to viscosity and electrical conductivity only; this mode gets modified due to the Hall term and the finite ion Larmor radius. In the case of propagation transverse to the magnetic field, all the transport coefficients contribute to the damping of waves. (auth)

9318 INVESTIGATION OF THE FORMATION OF A PLASMA RING IN A TRANSVERSE MAGNETIC FIELD. Alimov, A. K.; Umarov, G. Ya. (Physical-Technical Inst., Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 52-4(1967). (In Russian).

An experimental investigation was made of the generation of a plasma loop in a transverse magnetic field by the simultaneous injection of several plasma bunches. The shock-wave method, based on the interaction of a linear pitch with the pulsed magnetic field generated by the pulsed current passing along the wall of a discharge chamber, was employed for plasma injection. A quartz cylinder 100 mm in diameter and 300-mm long served as the discharge chamber. The investigation was carried out by means of high-speed photography with the aid of an SFR photorecorder. The injection of plasma bunches into the chamber produced a plasma ball. The injection of these bunches into a quasi-stationary magnetic field produced a plasma loop which performed an oscillating motion. The injection of bunches with a low speed into a weak magnetic field also produced a plasma loop; after 4 to 5 μsec of its life, characteristic instabilities appeared which lasted more than 10 to 12 μsec. When the speed of the plasma bunches injected into a strong magnetic field was increased, a stationary plasma loop appeared which lasted 10 μsec and longer. This loop shrinks to the center of the chamber, then unclamps, and again shrinks, i.e., oscillates. (ATD)

9319 PLASMA WAVE ECHO EXPERIMENT. Malmberg, J. H.; Wharton, C. B.; Gould, R. W.; O'Neil, T. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Rev. Lett., 20: 95-7(Jan. 15, 1968).

Experimental observation of a new nonlinear plasma phenomenon, the plasma wave echo, is reported. (auth)

9320 NORMAL INCIDENCE OF ELECTROMAGNETIC WAVES ON SEMI-INFINITE LONGITUDINALLY DRIFTING MAGNETO-PLASMA: THE NONRELATIVISTIC SOLUTION. Unz, Hillel (Univ. of Kansas, Lawrence). IEEE (Inst. Elec. Electron Eng.) Trans. Microwave Theory Tech., MTT-15: 432-3(July 1967).

A nonrelativistic solution is presented to the problem of normal incidence of electromagnetic waves on a semi-infinite longitudinally drifting homogeneous cold magnetoplasma. Reflected and transmitted waves from the drifting boundary were found and the results shown to be identical with a relativistic solution presented earlier by the author. A quadratic equation is derived from which the refractive index of the drifting plasma is obtained. By use of the values for refractive index, it is shown how the amplitudes of the reflected waves and of the drifting waves may be determined in terms of the amplitude of the incident wave. (BBB)

9321 WAVE PHENOMENA IN PLASMAS. Haskell, R. E. (Oakland Univ., Rochester, Mich); Papa, R. J. IEEE (Inst. Elec. Electron. Eng.) Trans. Educ., E-10: 15-25(Mar. 1967).

Propagation of waves in uniform, unbounded plasmas is reviewed, with emphasis on the various approaches and plasma models which may be used. The results and limitations of the different methods are discussed and compared. Four separate approaches corresponding to different levels of information may be used in analyzing wave phenomena in plasmas. The orbit theory model used to analyze cold plasmas is the simplest approach and yet is capable of uncovering many important characteristics of wave propagation in anisotropic plasmas. The effects of ion motion on the propagation of waves in a cold plasma may be studied from the orbit model. It is possible to include collisional damping in this analysis, which is satisfactory if the plasma frequency and collision frequency are interpreted as effective parameters which are functions of frequency and the electron temperature. This procedure introduces a temperature effect through the collision frequency, but the major effect of a finite temperature on the propagation of waves in a plasma cannot be determined from the orbit theory model. The simplest method of including the effects of thermal motions is through the pressure gradient terms which appear in the momentum equations of the various plasma species. To describe phenomena, such as cyclotron and Landau damping, which depend for their existence upon a finite spread in the electron (or ion) velocities, it is necessary to deal directly with the velocity distribution function. For certain types of collision dominated plasmas in a magnetic field, a conducting fluid model is often the most useful approach. The time and length scales of many cosmic plasmas result in large magnetic Reynolds numbers, giving rise to low-frequency wave phenomena, which is indicative of a strong coupling between the plasma motion and the magnetic field. In an appendix, an expression for the dielectric tensor of a cold, collisionless plasma in a magnetic field is derived by considering the motion of an average electron. Dispersion curves for the different models are presented in the form of ω-k plots. (BBB)

9322 AMPLIFICATION OF MICROWAVES BY THE INTERACTION OF AN ELECTRON BEAM WITH A CESIUM PLASMA. Katoh, Hidehiko; Ayaki, Kazuo; Ozawa, Masayoshi; Asami, Yoshihiro (Nippon Electric Co., Ltd., Kawasaki, Japan). Electron. Commun. Jap. (Engl. Transl.), 49: 84-90(Aug. 1966).

When an electron beam is passed through a gaseous plasma, amplification of a signal near the plasma frequency occurs. The interaction mechanism between such a beam and a plasma, and the amplification phenomenon in a beam–plasma system, were studied. Feasibility of its practical application was also examined. In the experiments described, an electron beam was passed through a Cs plasma generated by tungsten heaters in a Cs atmosphere. The frequency of maximum gain increased with the heater temperature. A gain of 24 db was obtained at 4000 MHz when the temperature of the tube wall was 67°C (vapor pressure of Cs = 8×10^{-5} mm Hg). The plasma density was measured by the double-probe technique. It was shown that the frequency of maximum gain corresponds to the plasma frequency. The noise figure of the amplifier was measured and found to be in the range of 25 to 35 db. The noise figure was found to be dependent on the pressure of the tube and was little affected by the presence of the plasma. (BBB)

9323 FORCES OF INTERACTION OF AN ELECTROMAGNETIC WAVE WITH A PLASMOID. Lobanov, Yu. N.; Lonskii, E. S.; Urazakov, E. I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 10-15(Mar.-Apr. 1967). (In Russian).

The forces acting in free space on a spherical plasmoid from the side of incidence of a plane electromagnetic wave are calculated. A sphere is taken as the plasmoid model, and it is assumed that its characteristics are unchanged during interaction with the field, that the plasma is completely ionized and is quasi-neutral. (TSS)

9324 PHYSICAL INTERPRETATION OF THE PLASMA DESCRIPTION IN MAGNETOHYDRODYNAMICS. Frank-Kamenetskii, D. A. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 7-18(1967). (In Russian).

A system of equations of multicomponent magnetohydrodynamics is examined from the physical point of view. The principle of Galileo invariance was used for the selection of the most convenient system of reading, in the nature of which was adopted a system connected with the neutral components of the plasma. In this reading system the simple unitary description of motion and transfer processes across the magnetic field was used. Thermodiffusion and thermoforce were introduced into the equations by means of the graphic heuristic method. (tr-auth)

9325 PULSE EFFECTS OF MOTION PROCESSES OF PLASMA FILAMENTS. Kazarnovskii, D. M.; Kulandin, A. A.; Khoroshavin, A. V. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 67-73(1967). (In Ruxssian).

Equations, describing the movement process of plasma filaments in pulse current, were studied. The dependence of the inductivity on the path traveled by the plasma and the separation of this path into two regions were resolved under conditions of linear approximation. The comparison with published data indicates the possibility of introducing such assumptions and makes it possible to evaluate the effect of the induction process, capacity, and other factors. (tr-auth)

9326 ASYMPTOTIC SOLUTION OF THE KORTEWEG–DE VRIES EQUATION. Karpman, V. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett., 25A: 708-9(Nov. 20, 1967).

The equation $u_t + uu_x + \beta u_{xxx} = 0$ describing nonlinear dispersive waves is considered. When parameter β is sufficiently small, the initial disturbance breaks into a large number of solitary waves. The distribution function for solutions is derived. (auth)

9327 NONLINEAR DEMODULATION OF AN AMPLITUDE-MODULATED ELECTROMAGNETIC WAVE PROPAGATING IN A MAGNETOPLASMA. Ram, Sant; Kaw, P. K. (Indian Inst. of Tech., New Delhi). Can. J. Phys., 45: 3991-4010(Dec. 1967).

Explicit expressions for the electric vector of an amplitude-modulated electromagnetic wave propagating along the direction of an applied magnetic field in a nonlinear ionized medium have been obtained, when the wave frequency is equal to the gyrofrequency of the electrons. It is seen that the wave gets strongly demodulated after propagation through the magnetoplasma as well as after reflection from a magnetoplasma–free space interface. Some numerical results, illustrating the variation of the demodulation with various plasma parameters, are presented in the discussion. (auth) (Canada)

9328 EXPERIMENTAL STUDIES OF THERMAL CONDUCTIVITY OF SODIUM AND POTASSIUM VAPORS AS A FUNCTION OF THE TEMPERATURE AND PRESSURE. Timrot, D. L.; Totskii, E. E. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 5: 793-801(Sept.-Oct. 1967). (In Russian).

Results of measurements of the thermal conductivity of sodium vapor at temperatures from 886 to 1264°K and pressures from 0.034 to 0.69 kg/cm^2 and of potassium vapor from 841 to 1241°K at pressures from 0.022 to 0.94 kg/cm^2 are reported. A method for the processing of the data obtained is proposed. A comparison is made with available calculated data. (tr-auth)

9329 PHYSICAL PROPERTIES OF PLASMA IN HELIUM MIXED WITH CESIUM VAPOR. II. Polushkin, I. N. (Kiev

State Univ.). Teplofiz. Vys. Temp., 5: 778-82(Sept.-Oct. 1967). (In Russian).

Physical properties of cesium-seeded helium discharge plasmas at constant pressure of 60-mm Hg were investigated in pulse regime at current densities from 3 to 80 A/cm^2. It is shown that, in the mixed regime, the atoms of the admixture have a Boltzmann distribution in the excited state, so that the temperature of the electrons and the concentration of the charged particles can be calculated by the Saha equation at the same temperature. Some questions of the energy balance in the plasma column are examined. (tr-auth)

9330 IMPORTANCE OF THE CAPACITANCE BETWEEN THE COIL AND PLASMA IN PLASMA ELECTROCONDUCTIVITY DETERMINATION BY PROFILE METHODS. Levin, A. L.; Poberezhskii, L. P. Teplofiz. Vys. Temp., 5: 769-77(Sept.-Oct. 1967). (In Russian).

The effect of the capacitance between coil and plasma during the measurement of the electric conductivity of plasma by the quality or resonance frequency of the profile in the radio-frequency range is considered. The relations, determining the size of the active loss and increase of the capacitance of the profile by interaction with the plasma, are obtained. The condition for the maximum active loss is determined. Experiments were carried out, verifying the relations obtained. It is shown that, by means of a grounded screen between the coil and plasma, the effect of the capacitance on the results of the measurement of the electroconductivity can be eliminated and that factors influencing the capacitance are reduced by reduction of the coil length. (tr-auth)

9331 KINETIC ENERGY EXCHANGE IN A DENSE WEAKLY IONIZED ARGON PLASMA. Aleksandrov, V. Ya.; Gurevich, D. B.; Podmoshenskii, I. V. Teplofiz. Vys. Temp., 5: 751-5 (Sept.-Oct. 1967). (In Russian).

The investigation of the energy balance of arcs in Ar atmosphere is reported. The electron concentration, excitation temperature, and gas temperature were measured. The analysis of the results obtained indicate that the kinetic energy exchange between electrons and heavy particles proceeds by at least one order of magnitude faster than elastic collisions. A possible mechanism for the kinetic energy exchange in inelastic collisions is proposed. (tr-auth)

9332 EXPERIMENTAL AND THEORETICAL STUDIES OF THERMAL CONDUCTIVITY COEFFICIENT AND COMPLETE NITROGEN PLASMA RADIATION. Asinovskii, E. I.; Drokhanova, E. V.; Kirillin, A. V.; Lagar'kov, A. N. (Inst. of High Temperatures, Moscow). Teplofiz. Vys. Temp., 5: 739-50 (Sept.-Oct. 1967). (In Russian).

By two independent methods, the important role of radiation in the energy balance of the axial region of stabilized arcs in nitrogen was established. Data were obtained on the heat conductivity coefficient and the radiation of nitrogen at atmospheric pressure in the temperature interval from 10,000 to 15,000°K. (tr-auth)

9333 INSTABILITY OF MAGNETO-ACOUSTIC WAVES IN LOW-PRESSURE PLASMAS. Ricketts, Brian W. (Univ. of Sydney). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 153-5 (Jan. 1968).

It was shown that a simple linear theory of the stability of magneto-acoustic waves indicates strong growth mechanisms at low pressures. (M.O.W.)

9334 ION COLLECTION FROM LOW-SPEED IONIZED GAS. Kulgein, Norman G. (Lockheed Palo Alto Research Lab., Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 151-3(Jan. 1968).

Experiments and simplified theoretical correlations are presented for the collection of positive ions by cylinders immersed in a stream of subsonic weakly ionized gas. (M.O.W.)

9335 EXPERIMENTAL STUDY OF FORCES ON A BODY IN A MAGNETIZED PLASMA STREAM. Kawashima, Nobuki; Mori, Sigeru (Japan Atomic Energy Research Inst., Ibaraki). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 6: 110-13(Jan. 1968).

Lift and drag on a thin aluminum plate (wing) placed in a magnetized plasma stream with a small angle of attack are investigated experimentally. Ions in the plasma stream undergo nearly perfect diffuse reflection on the surface of the body. When the magnetic field is parallel to the plasma stream, the ratio of the lift to the drag L/D increases with the magnetic field strength. For a magnetic field transverse to both the plasma stream and the surface of the aluminum plate, the ratio L/D decreases as the magnetic field is increased. These are explained by the fact that the spiral motion of ions in the plasma stream in the magnetic field and the effect of the return of ions reflected on the surface of the plate by the magnetic field cause the change of the ratio L/D with the magnetic field strength. When the magnetic field is transverse to the plasma stream but parallel to the surface of the plate, the effect of the magnetic field corresponds to the change of the angle of attack of the plasma stream to the plate, and this causes either increase or decrease of the total force on the plate depending on the polarity of the magnetic field. (auth)

9336 FLIGHT OF A CIRCULARLY CHARGED CLUSTER ALONG THE AXIS OF A SEMI-INFINITE CIRCULAR WAVEGUIDE. Urazakov, E. I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 22-8(Mar.-Apr. 1967). (In Russian).

The Wiener–Hopf method is used to determine the field excited by a distributed axisymmetric charged cluster traveling along the axis of a semi-infinite circular waveguide with walls of finite conductivity. The fields of the excited TM$_0$ modes are determined by the component of the vector potential A_z. (TSS)

9337 UNIFIED SHOCK PROFILE IN A PLASMA. Grad, Harold; Hu, Pung Nien (Space Sciences Inc., Waltham, Mass.). Phys. Fluids, 10: 2596-2602(Dec. 1967).

Previously (P. N. Hu, Phys. Fluids 9, 89 (1966)), a universal monotonic profile was found for a weak plasma shock propagating perpendicular to a magnetic field using an elaborate set of moment equations which included electron and ion viscosity, coupled electron and ion heat conduction, thermal diffusion, and resistivity, together with distinct Hall terms for the resistivity, stress, and heat flow. Inclusion of an additional term related to electron inertia now gives a one-parameter family of profiles which spans the entire range from collision-dominated monotonic profiles to damped oscillatory profiles and the limiting collisionless case of purely oscillatory and solitary wave profiles. (auth)

9338 PROPOSED MODIFICATION TO HARRIS' QUASI-LINEAR EQUATIONS. Manheimer, Wallace M. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 10: 2710-12(Dec. 1967).

Several modifications are made to the quasi-linear equations of Harris which distinguish between weakly and strongly damped modes and between the tail and body of the particle distribution function. (auth)

9339 PROPAGATION OF LONGITUDINAL WAVES INTO A NONUNIFORM PLASMA. Leavens, William M. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Phys. Fluids, 10: 2708-10(Dec. 1967).

Numerical solutions of the Vlasov equation for plasma wave propagation through a sheath into a nonuniform plasma have been obtained. A strong wave is excited for frequencies slightly above the plasma frequency at the sheath edge. (auth)

9340 TRANSPORT PROPERTIES OF A NONEQUILIBRIUM PARTIALLY IONIZED GAS IN A MAGNETIC FIELD. Chmieleski, Robert M.; Ferziger, Joel H. (Stanford Univ., Calif.). Phys. Fluids, 10: 2520-30(Dec. 1967).

A modified Chapman–Enskog technique developed for a partially ionized gas in an electric field is generalized to include the effects of a magnetic field. The method allows the electron and heavy particle temperatures to differ while requiring all species to have the same macroscopic velocity to zero order. Expressions are obtained for the transport properties of such a gas and a complete set of self-contained magnetohydrodynamic equations is given. As an example, the transport properties of a fully ionized gas containing a single ion species are evaluated using the cutoff Coulomb potential. In the limit of equal electron and ion temperatures, the results are in agreement with previous results. (auth)

9341 NEW MECHANISM FOR LOW-FREQUENCY OSCILLATIONS IN PARTIALLY IONIZED GASES. Roth, J. Reece (Lewis Research Center, Cleveland). Phys. Fluids, 10: 2712-4(Dec. 1967).

An outline is given of the theory underlying a class of low-frequency oscillations in partially ionized gases that are described by the operation of the plasma continuity equations. (auth)

9342 APPROXIMATE EQUATIONS FOR CALCULATION OF THERMODYNAMIC DATA FOR A HIGH-TEMPERATURE AIR-CARBON MIXTURE (CALCULATION WITH THE AID OF COEFFICIENTS). Kuthe, Rolf (Technische Hochschule, Brunswich). Z. Flugwiss., 15: 67-77(1965). (In German).

A method is described for estimating the thermodynamic data for an air–carbon plasma (ratio of nitrogen to oxygen 79 : 21) with an arbitrary C content in the so-called atomic region. The method is based on the practically linear relation which, at constant temperature and constant pressure, exists between various thermodynamic quantities and the C content. The gradient of the function $\phi = f(\chi_C)$ can be estimated from any of the thermodynamic data known for pure air (i.e. for an air–C mixture at a C content of

$\chi_C = 0$), provided the relevant thermodynamic data for one additional air–carbon mixture is known. Once the gradients are calculated as functions of temperature and pressure, the appropriate numerical values for any arbitrary air–C plasma can be calculated from the thermodynamic data of pure air. Based on these conceptions, approximate equations of the form $(\phi_L - \phi_{\chi_C})/\chi_C = K_{L'}(\phi)$ could be derived for calculating compressibility factor, enthalpy, and entropy. The coefficients $K_{L'}(\phi)$ were calculated and represented in form of a diagram as functions of temperature and pressure. By application of these basic equations and the common relations of thermodynamics, approximate formulae also could be obtained for other parameters. The error due to these approximations was generally less than 1% over the range of temperatures from 6,000 to 100,000°K at pressures between 100 and 0.001 bar. (BBB)

9343 DIRECT MEASUREMENT OF MASS PICKUP IN A LOW-ENERGY THETA PINCH. Harris, Robert W. (Sandia Lab., Albuquerque, N. Mex.). Phys. Fluids, 10: 2675-9(Dec. 1967).

A balanced magnetic probe technique has been used to determine the drive force acting on the plasma sheath during the first pinch. The sheath motion was studied with the probe technique, and with image converter framing pictures. The sheath mass was determined from the velocity and the time integral of the drive force. The results indicate an average pickup coefficient of 0.82 ± 0.06 for the first half of the pinch. Electron density and temperature were determined during the first half of the pinch by measurement of the H_β line profile. Combination of the spectroscopic and mass data indicates an average sheath ionization lower than predicted by theory, but the experimental error in the ionization determination precludes a definite conclusion to this effect. (auth)

9344 RADIATION LOSSES FROM A TEST PARTICLE IN A PLASMA. McKenzie, J. F. (Ames Research Center, Moffett Field, Calif.). Phys. Fluids, 10: 2680-94(Dec. 1967).

A formula is derived for the average rate of energy loss suffered by a charged particle moving in a helical orbit in a homogeneous medium. In a cold, magnetized plasma it is shown that the Cherenkov excitation of the whistler and ion cyclotron waves depends critically on certain characteristic wave speeds relative to the component of the particle's velocity parallel to the magnetic field. The power spectrum of Cherenkov radiation exhibits sharp peaks not only at the frequencies of the lower and upper hybrid resonances but also at those frequencies at which the ray phase velocity equals the particle's velocity, $v_{||}$, parallel to the magnetic field. An intriguing feature of this radiation is that the more slowly the particle moves along the magnetic field, the greater is the emitted radiation; the power emitted in the whistler mode also becomes large when $v_{||}$ equals the group speed of those waves that are beamed along the magnetic field. By using a simple graphical construction one can readily locate those directions in which the angular distribution of synchrotron radiation is sharply peaked. (auth)

9345 STIMULATED BRILLOUIN EFFECT IN MAGNETOPLASMAS. Pomeau, Y. (Univ., Paris, Orsay, France). Phys. Fluids, 10: 2695-2701(Dec. 1967).

The manner in which a pumping wave of high amplitude can produce parametric instabilities in a plasma is investigated. A very simple derivation of the nonlinear polarizabilities is given for the case when the pumping wave is homogeneous. From this nonlinear polarizability, a derivation of the accurate nonlinear dispersion relation is given. One finds unstable waves by solving this nonlinear dispersion relation. The critical level of the pumping wave is very much reduced if the proper modes allow carrying out the stimulated Brillouin effect. A pumping wave with a cyclotron resonance gives a particularly low critical level. (auth)

9346 RADIATION FROM LASER-HEATED PLASMAS IN NITROGEN AND ARGON. Daiber, J. W. (Cornell Aeronautical Lab., Inc., Buffalo); Winans, J. G. J. Opt. Soc. Amer., 58: 76-80(Jan. 1968).

The time-integrated radiant energy from laser-produced and laser-heated breakdown plasmas was spectroscopically examined. The spectra consisted of a strong continuum with several lines. Band spectra characteristic of molecular species could not be detected in pure diatomic gases. The lines were very broad especially in the same spatial region as that from which the continuum was emitted. Line spectra emitted from outside this region were predominantly from un-ionized atoms. The spectral lines from singly ionized atoms were emitted in a volume only slightly larger than that for the continuum. Photomultiplier–interference-filter measurements of the afterglow indicated that in nitrogen the atom lines last five times as long as do the ion lines. When the peak laser power exceeded 600 MW the spectrum of doubly ionized nitrogen atoms was detected. The absence of molecular spectra and the threshold for the appearance of doubly ionized nitrogen indicate that the plasma may be in a state of total equilibrium at a high temperature. (auth)

9347 EXCITATION OF IONIC SOUND IN A PLASMA IN A STRONG ELECTRIC FIELD. Zaitsev, A. A.; Milich, B.; Rukhadze, A. A.; Shvilkin, B. N. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 37: 1607-16(Sept. 1967). (In Russian).

The excitation of ionic sound in a weakly ionized and a fully ionized plasma in a strong electric field was discussed. The calculations were undertaken because earlier treatments did not take into account ion–ion collisions and were therefore not applicable to fully ionized plasmas, and neglected electron collisions without providing a criterion for the validity of that approximation. In the present work the longitudinal dielectric constant of each type of plasma in an electric field is calculated, the dispersion equation for ionic sound waves is derived, and limits are found for the wavelengths of ionic sound oscillations that can be spontaneously excited. In the calculations it is assumed that the external electric field is such that the drift velocity of the electrons is small compared with their thermal velocity. The authors experimentally investigated the excitation and propagation of ionic sound in weakly ionized plasmas produced by 30- to 150-mA currents in 3- to 4-cm-diameter 80-cm-long tubes containing helium at pressures below 0.1-mm Hg. The noise generated in the plasma was detected with a type FEU-19M photomultiplier, and the dispersion of the ionic sound component was investigated with the aid of a resonant filter with a 2-kHz pass band between the photomultiplier and the oscilloscope. The wavelength of the ionic sound was determined by moving the photomultiplier along the discharge tube and noting the consequent phase shift of the recorded oscillations. Ionic sound was observed at helium pressures below 0.01-mm Hg. The longest observed wavelength at each of several pressures was in good quantitative agreement with the calculated upper limit to the wavelength spectrum of spontaneous ionic sound, but the shortest observed wavelength was considerably greater than the calculated lower limit to the spectrum. This discrepancy is ascribed to scattering of the ionic sound on plasma particles with consequent increase of the wavelength. (ATD)

9348 NONLINEAR INTERACTION OF IONIC SOUND WAVES IN A TURBULENT PLASMA. Liperovskii, V. A.; Tsytovich, V. N. (Moscow Inst. of Electronic Machine Building). Zh. Tekh. Fiz., 37: 1623-9(Sept. 1967). (In Russian).

The propagation of ionic sound waves in a plasma in which there is present a group of intense ionic sound waves with random phases and frequencies lying within a narrow range about some frequency f_0 is discussed. The dispersion equation for ionic sound waves in such a plasma is derived with the contributions to the conductivity of the plasma from terms that are quadratic and cubic in the electric field strengths taken into account. The cubic terms are found to be less significant in the case of ionic sound waves than in the case of Langmuir waves. With the aid of the dispersion equation it is shown that different types of instability can occur, and conditions for the appearance of the different instabilities and expressions for their magnitudes are derived. In particular, there can occur a resonance decay of an ionic sound wave with wave vector k and frequency $f < f_0$ into two ionic sound waves with wave vectors k_i and frequencies f_i ($i = 1, 2$) such that $k_1 + k_2 = k$ and $f_1 + f_2 = f$, which is forbidden in the linear dispersion theory of a weakly turbulent plasma. The investigated processes can very significantly affect the electric conductivity of a turbulent plasma. (ATD)

9349 RELATIONSHIP OF LONGITUDINAL, SURFACE, AND TRANSVERSE WAVES ON PLASMA BOUNDARY. Chakrabroti, B. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 5, 30-8(Sept.-Oct. 1966). (In Russian).

It is shown that the transverse wave in a plasma excites surface waves, compressional waves, and longitudinal waves. General expressions are developed for the amplitude, energy intensities, and phases of all four types of waves, including the reflection wave in a vacuum. (tr-auth)

9350 EXCITATION OF ELECTROMAGNETIC WAVES IN A PLASMA BY A CONCENTRATED SOURCE. Genchev, Zh. D.; Kalmykova, S. S. Zh. Tekh. Fiz., 37: 1641-7(Sept. 1967). (In Russian).

Electromagnetic waves, particularly surface waves, excited in and on the surface of a semi-infinite plasma by an alternating current flowing in a line located in the surface of the plasma are discussed. Three cases are treated: a semi-infinite plasma bounded by an infinite nonconducting plane, a semi-infinite plasma bounded by an infinite plane of which one-half is perfectly conducting and the other half, which meets the conducting half in a straight line, is nonconducting; and a plasma filling the interior of one of the dihedral angles formed by two perpendicular perfectly conducting planes. The first case was treated for comparison with the second and third cases, which are intended to represent a plasma issuing from the interior of a conducting cylinder whose radius is large compared with the wavelength and other lengths involved, and a plasma within a large rectangular plasma waveguide with conducting walls, respectively. The plasma is represented by a constant complex anisotropic dielectric tensor. Expressions are obtained for the total power radiated and the energy flux in the surface wave as functions of the dielectric tensor of the plasma and the distance of the line current from the edge of the dihedral angle or from the line separating the conducting and nonconduction parts of the plane boundary of the plasma. The results should be of use in plasma diagnostics and in the investigation of the diffraction characteristics of inhomogeneous sections of dielectric waveguides. (ATD)

9351 DECAY OF WEAK MAGNETOHYDRODYNAMIC SHOCK WAVES. Korobeinikov, V. P. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 25-30(1967). (In Russian).

The decay of magnetohydrodynamic waves with small amplitudes is investigated. It is assumed that the magnetic Reynolds number is very large and all dissipative effects are neglected. For transverse and longitudinal magnetic fields the density jumps across the shocks are calculated. The case is then generalized to the propagation of a slow or fast shock wave into an inhomogeneous medium. (TSS)

9352 MAGNETOGASDYNAMIC SHOCK WAVE WITH DISCONTINUOUS ELECTRIC CONDUCTIVITY. Gusika, P. L.; Sukhov, G. S. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 18-24(1967). (In Russian).

The properties of magnetogasdynamic shock waves are analyzed in monatomic plasmas, including ionization processes. It is assumed that the gas is un-ionized ahead of the shock wave but possesses infinite electric conductivity behind the shock wave. For $T < T_*$, the magnetic field is constant, $B = B_1$ and for $T > T_*$ the E field is given by $uB - v_m(dB/dx) = E = \text{const}$. A u–B phase diagram is constructed to study the flow across the shock for cases where T_1 and T_2 (before and after the shock wave, respectively) are either less than or greater than the critical temperature T_*. For example, when $T_1 < T_2 \leq T_*$, the shock wave is a simple gas dynamic wave. The ionization rate is calculated, using the Saha equation. It is shown that a magnetogasdynamic shock wave can exist when $M_{*1} \geq \sqrt{1 + A_{*1}^2}$ where A_{*1} is the Alfvén wave. The degree of compression ρ_2/ρ_1 is calculated and is shown graphically as a function of T_1 and M_1. (ATD)

9353 ELECTRON-TEMPERATURE DEPENDENCE OF ELECTRON–ION RECOMBINATION IN NEON. Frommhold, Lothar; Biondi, Manfred A.; Mehr, F. J. (Univ. of Pittsburgh). Phys. Rev., 165: 44-52(Jan. 5, 1968).

A 3-mode microwave apparatus is used to determine electron-ion diffusion and recombination rates under conditions such that $T_+ = T_{gas} = 300°K$ and T_e is varied from 300 to 11,000°K. A high-Q cavity mode is used to ionize the gas, a second high-Q mode is used to determine the electron density during the afterglow from the change of resonant frequency of the cavity, and a nonresonant waveguide mode is used to apply a constant microwave heating field to the electrons. At $T_e = 300°K$ and p(Ne) = 20 torr, a value $\alpha(Ne_2^+) = (1.7 \pm 0.1) \times 10^{-7}$ cm^3/sec is obtained from analysis of the recombination-controlled electron density decays, using a computer solution of the electron continuity equation to take into account ambipolar diffusion effects. This value is in very good agreement with corrected values obtained by several other investigators. Using the same procedures, a variation of $\alpha(Ne_2^+)$ as $T_e^{-0.43}$ is found to be accurately obeyed over the range $300°K \leq T_e \leq 11{,}000°K$, suggesting that the initial capture step is rate-limiting in the dissociative recombination process. (auth)

9354 MEASUREMENT OF COLLISIONAL RATE COEFFICIENTS FOR HELIUMLIKE CARBON IONS IN A PLASMA. Kunze, H.-J.; Gabriel, A. H.; Griem, Hans R. (Univ. of Maryland, College Park). Phys. Rev., 165: 267-76(Jan. 5, 1968).

Measurements of the emitted line intensities from a θ pinch discharge are interpreted in terms of a modified corona model for heliumlike ions. The relative intensities of the resonance and intercombination lines have been measured for C V and O VII as a function of time, as has the absolute intensity of the C V 2^3S-2^3P multiplet. Electron temperatures and densities are obtained as functions of radius and time from the spectrum of Thomson-scattered laser light, and the densities also from Abel-inverted absolute continuum intensities. The derived model allows for population of the n = 2 levels by direct impact excitation and by cascading, for collision-induced (exchange) transitions from n = 2 triplets to singlets, and for collisional ionization from both the ground and the n = 2 triplet levels. Collisional de-excitation of the triplets is shown to be negligible compared with exchange collisions and radiative transitions. Singlet excitation rates (near threshold) are derived with an accuracy of 40% which agree with Seaton and Van Regemorter's semiempirical formulas, triplet excitation rates which are smaller than the singlet rates by a factor 1.8 ± 0.2, and ground-state ionization rates to an accuracy of 25% agreeing with those estimated from the Born-exchange approximation for hydrogenic ions, suitably modified for two-electron systems. The measured value for the triplet-singlet exchange rate for C V is equal to $\frac{1}{5}$ of the value calculated for He I using the close-coupling approximation, and it has an estimated accuracy of 25%. (auth)

9355 POSSIBILITY OF SECOND SOUND IN TURBULENT PLASMA. Ichimaru, Setsuo (Univ. of Illinois, Urbana). Phys. Rev., 165: 251-2(Jan. 5, 1968).

The propagation of energy density waves associated with the "gas" of acoustic plasma oscillations in a turbulent plasma is investigated. It is shown that a second-sound wave exists, and that it can grow exponentially under certain nonequilibrium conditions. (auth)

9356 THEORY OF A TURBULENT STATIONARY STATE OF A PLASMA. Ichimaru, Setsuo (Univ. of Illinois, Urbana); Nakano, Tohru. Phys. Rev., 165: 231-50(Jan. 5, 1968).

A self-consistent scheme was used to determine the fluctuation spectrum for a class of turbulent plasmas in which a conventional theory predicts an exponential growth of the density-fluctuation excitations, or instability. This theoretical approach is based on the fundamental postulate that a proper inclusion of the correlation effects or the existence of the fluctuations in the stationary state should be able to remove the instability and lead to a description of the most stable state for the turbulent plasma. A dielectric response function $\epsilon(k,\omega)$ for such a turbulent plasma is calculated within the validity of the hydrodynamic description. In this calculation, there are involved various polarization processes associated with the interaction between the external test charge (or the induced fluctuations) and the turbulent fluctuations existing in the plasma; the nature of those processes is clarified with the aid of diagrammatic considerations. The fluctuations of the internal electric field give rise to an additional mechanism for particle diffusion; the effective diffusion coefficient in the turbulent plasma is obtained by investigating the behavior of $\epsilon(k,\omega)$ in the limit of long wavelengths and low frequencies. The effects of turbulence upon the properties of the ion acoustic wave are studied. Following the self-consistent scheme, an integral equation is derived for the fluctuation spectrum associated with the acoustic mode; it is then solved for values of the electron drift velocity V_d above and below the critical one, V_c. We thus find that the results indeed support our original postulate, and the dielectric response function remains stable for the entire range of the drift velocity. The over-all structure of the fluctuation spectrum is investigated. In terms of the small plasma parameter, $g \equiv 1/n_0\lambda_D{}^3$, the energy $\epsilon(k)$ in the acoustic mode with wave vector k is of the order of g (i.e., around the thermal level) in the stable region; as the plasma enters the transition region, $k \cdot V_d \simeq V_c$, the order of $\epsilon(k)$ goes up to $g^{1/2}$; in the turbulent region, $\epsilon(k)$ contains a part of the order of g^0. It is also shown that a certain domain of the turbulence spectrum can be explained with the aid of a dimensional argument. The results of the calculations are compared with a fluctuation spectrum measured by a microwave scattering experiment. (auth)

9357 LOW-FREQUENCY COMPONENT ELECTRIC MICROFIELD DISTRIBUTIONS IN PLASMAS. Hooper, C. F. Jr. (Univ. of Florida, Gainesville). Phys. Rev., 165: 215-22 (Jan. 5, 1968).

Low-frequency component electric microfield distributions in a plasma are calculated at both a neutral and a charged point. It is shown that this calculation allows for the inclusion of all correlations to a high degree of accuracy. The theory is compared with the Holtsmark and Baranger–Mozer theories. A detailed analysis of all approximations is included, together with a Monte Carlo study. Numerical results are shown both graphically and in tabulated form. (auth)

9358 ION ACOUSTIC WAVES IN A COLLISIONAL PLASMA. Buti, B. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 165: 195-201(Jan. 5, 1968).

The damping of the ion acoustic waves by Coulomb collisions is studied by using the Fokker–Planck equation of Rosenbluth et al., for both the species constituting the plasma, namely, the electrons and the ions. In a plasma with weak collisions and in the absence of any external field, one finds that irrespective of the ratio T of the ion temperature to the electron temperature, the characteristic frequency gets affected only by the electron–ion collisions. However, as far as the collisional damping is concerned, both the ion–ion and the electron-ion collisions play a somewhat equally important role; the electron–electron and the ion–electron contributions are negligible compared to the other two. The damping increases with increase in the collision frequency but decreases with increase in T. (auth)

9359 THERMODYNAMIC FUNCTIONS OF FREE PROTONS AND ELECTRONS IN A HYDROGEN PLASMA. **Theimer, O. (New Mexico State Univ., University Park); Kepple, P. Phys. Rev., 165: 168-71(Jan. 5, 1968).**

The electrostatic contribution to the internal energy of the free charges of a hydrogen plasma is computed by numerically solving a modified Poisson–Boltzmann equation. The particles of the plasma are classified as bound or free according to whether their total energy is less than or greater than a parameter E^* ($E^* \leq 0$). The dependence of the thermodynamic functions on the parameter E^* is investigated by making calculations for several values of E^*. (auth)

9360 CALCULATION OF TEMPERATURE PROFILES AND CHARACTERISTICS OF CHANNEL ARCS FOR ARGON, NITROGEN, AND HYDROGEN BY THE STEPWISE APPROXIMATION METHOD. **Zarudi, M. E.; Edel'baum, I. S. (All-Union Research Inst. of Electrothermal Equipment, Moscow). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 3-7(Feb. 1967). (In Russian).**

Using the method of stepwise approximation, which presupposes the division of the arc into a number of cylindrical coaxial regions, the authors calculated arcs burning in an atmosphere of argon, nitrogen, and hydrogen at a channel radius of 5×10^{-3} m. As initial data for calculating argon, nitrogen, and hydrogen arcs at a pressure of 10^5 N/m^2, the investigators used the theoretical dependences $\lambda(T)$ and $\sigma(T)$ borrowed from various sources. The temperature distributions obtained for the argon arcs had smooth profiles, typical of monatomic gases since the only determining factor here is gas ionization. For the molecular gases (nitrogen and hydrogen) the temperature profiles were different owing to dissociation of these gases occurring at relatively low temperatures. The nitrogen arcs had the greatest change of profile, which was related with the high dissociative thermal conductivity of nitrogen, as a consequence of which the temperature of these arcs in the dissociation region increases slowly. It is pointed out in conclusion that the obtained characteristics are of a qualitative nature because the transfer properties of gases used as the initial data were calculated without consideration of radiation. (ATD)

9361 CALCULATION OF THE CHARACTERISTICS OF A STABILIZED ARC DISCHARGE. **Kozlov, G. I. (Inst. of Mechanical Problems, Moscow). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 36-40(Feb. 1967). (In Russian).**

To derive equations describing processes in a stabilized arc discharge, the author examines a model in which the arc column is a current-conducting channel with the radius of the arc varying over its length. This channel, so to speak, is blown by a coaxial flow of gas moving in a cylindrical channel. Thus, the electrical field acts in the direction of gas flow. The energy equation is written on the assumption that the gas flow is axisymmetric and steady, the product of density and flow velocity is constant everywhere over the flow section, losses due to radiation are neglected, mass exchange between the plasma of the arc channel and the stabilizing gas flow is disregarded, thermal conductivity along the arc in comparison with radial conductivity is ignored, the electrical discharge is considered steady, Lorentz forces are disregarded, the electrical potential is constant everywhere in a plane perpendicular to the axis, and that the plasma in the arc discharge channel is in a state of thermodynamic equilibrium. Two regions are distinguished on the basis of the adopted model of the process: the region of the arc discharge column and the region of stabilizing gas flow. As an illustration the author presents the results of calculations for two limiting cases, between which fall the volt–ampere characteristics for all other possible arc stabilization regimes. (ATD)

9362 AERODYNAMIC CHARACTERISTICS OF A ONE-CHAMBER PLASMATRON WITH VORTEX GAS STABILIZATION AND ITS EFFECT ON ARC BEHAVIOR. **Lebedev, A. D.; Mortseva, G. I.; Smolyakov, V. Ya. (Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 53-9(Feb. 1967). (In Russian).**

Results are presented of an experimental investigation of gas flow in a shell-like inside electrode of a one-chamber plasmatron with vortex gas stabilization of the arc. The experimental investigations with "cold" blowing were carried out on transparent plastic models and with "hot" blowing (during burning of the arc) on their metal copies. The transparency of the model made it possible to observe the motion of the gas flows which were visualized by means of stained oil, sand grains, or water jets introduced into the flow at various points over the radius and length by means of a syringe. The aerodynamic effect of a one-chamber plasmatron on arc behavior is primarily evidenced by elongation of the arc after striking in the interelectrode space. In this case the end of the arc in the outlet electrode after reaching a certain length is shunted to the wall by a discharge developing after breakdown of the arc-electrode wall space. This phenomenon causes periodic fluctuations of arc length in the outlet electrode, the frequency of which depends on the rate of displacement of the arc spot and other factors. It was found that the frequency of shunting of the arc in the inside electrode was appreciably less than in the outlet electrode and that the range of fluctuations of its length was appreciably smaller. The former was related to smaller rates of motion of the end of the arc in the inside electrode and the latter was determined mainly by the greater instability of the arc column, which decreases the breakdown distance. (ATD)

9363 REGULATION OF ARC VOLTAGE IN A TWO-CHAMBER PLASMATRON BY CHANGING THE GAS FLOW RATIO THROUGH VORTEX CHAMBERS. **Lebedev, A. D.; Mortseva, G. I.; Smolyakov, V. Ya. (Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 60-4(Feb. 1967). (In Russian).**

Describing a two-chamber plasmatron as one having a second chamber situated near the bottom of the inside shell-like electrode and intended for changing the depth of penetration of axial circulation from the first (main) vortex chamber into the inside electrode, the authors show that by regulating the ratio of gas flows through the two vortex chambers in a two-chamber plasmatron it is possible to change the position of the reference spot of the arc in the inside electrode and hence the length of the arc in it. Since the question arises as to how a change of arc length affects the overall potential drop across the arc, the authors examine in detail how regulation of the arc voltage occurs in a two-chamber plasmatron upon a change of the ratio of gas flows through the vortex chambers while maintaining constant the total gas flow through the plasmatron. (ATD)

9364 COMPARATIVE CHARACTERISTICS OF TWO-CHAMBER AND BILATERAL PLASMATRONS. **Antipov, V. G.; Lebedev, A. D.; Smolyakov, V. Ya. (Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 65-9(Feb. 1967). (In Russian).**

The purpose of this investigation is to elicit the dependence of the parameters of a bilateral plasmatron on the quantity of ejected "nonworking" gas and to compare these parameters with the parameters of a two-chamber plasmatron. Copper water-cooled outlet and inside tubular electrodes and a central vortex chamber were common components to both configurations. In the investigated model the electrodes for both configurations were 600 mm long with 20 mm ID. The central vortex chamber was made out of an annular plastic insulator with 50 mm ID having 6 tangentially arranged holes 2.8 mm in dia. The investigations made it possible to obtain data on the characteristics of arc burning in the two-chamber and bilateral (with partial ejection of the gas) plasmatrons. The arc power was always higher in the bilateral plasmatron than in the two-chamber one at identical gas flow rates, current, and pressure; however, in this plasmatron some of the heated gas was ejected through the end of the inside electrode. Thus, the power of the useful jet decreased at the outlet from the plasmatron. The investigation showed that the two-chamber plasmatron has some advantage over the bilateral plasmatron with respect to higher thermal efficiency at identical heating temperature. However, this advantage is negligible, and when an increase of the service life of the plasmatron and its reliability are of greatest concern the plasmatron with partial ejection (unilateral) is a more promising configuration. (ATD)

9365 TRANSPORT COEFFICIENTS FOR A PARTLY IONIZED TWO-TEMPERATURE PLASMA WITH DIFFERENT MASSES OF IONS AND NEUTRAL PARTICLES. **Pekurovskii, L. E. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 16-24(May-June 1967). (In Russian).**

The coefficients of viscosity, thermal conduction and diffusion are calculated for a two-temperature, three-component plasma consisting of ions, neutral particles, and electrons for the case when the masses of ions m_i and neutral particles m_a are different. A numerical calculation is carried out for helium with cesium addition ($m_i > m_a$) and for krypton with lithium addition. (ATD)

9366 TEMPERATURE VARIATIONS AT THE DISCONTINUOUS BOUNDARY SURFACE OF PLASMA. **Takesada, Yoshihito (Kyoto Univ.). Bull. Kyoto Educ. Univ., Ser. B, No. 29, 5-8 (Aug. 1966).**

In a plasma, temperature waves exist between the superfluid stream and the normal fluid in the steady state. This wave is referred to in terms of the two-fluid model and is named the second sound wave. As to the propagation of the sound the relation between the increased rate of the entropy and the damping constant of the sound is clarified. When the shock stream of the particles spreads into the steady flow of the fluid, the temperature wave is generated at the discontinuous boundary surface. An analysis was made of the temperature change at the boundary surface characterized by both heat radiation and a temperature wave. From the results of the relation derived for the temperature variations with time at the discontinuous zone of fluids, if the initial tendency for the variation of the temperature is very low, the generated temperature at this site will rapidly increase. The mechanism discussed is applicable to other phenomena, such as the solar wind and those applicable to superconductive materials. (BBB)

9367 ON SEMIPHENOMENOLOGICAL THEORETICAL ANALYSIS OF ALFVEN WAVES IN A PLASMA OF FINITE ELECTRICAL CONDUCTIVITY. Draganu, Mircea (Univ. of Cluj). Rev. Roum. Sci. Tech., Ser. Mecan. Appl., 12: 7-42(1967). (In French).

Recently a semiphenomenological model for the theoretical analysis of Alfvén waves in a totally ionized electroionic plasma was proposed. The model is used only for Alfvén waves of low frequency. The electron contribution is represented phenomenologically through the property of the plasma to possess an electric conductivity, while the ions are considered statistically, their behavior being described by a Boltzmann–Vlasov equation. A Lorentz force corresponding to a macroscopic magnetic field present in the plasma appears. The problem may thus be reduced to the usual solution of a single Boltzmann–Vlasov equation. The model is applied to an infinitely conductive plasma and extended to the more general case of a plasma of finite electrical conductivity. (BBB)

9368 CONTRACTION OF POSITIVE COLUMN. Baranov, V. Yu.; Ul'yanov, K. N. (All-Union Electrotechnical Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 121-4(Sept. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 622-6(Sept. 1, 1967).

The contraction of current at medium pressures ($p \sim 5$ to 500 mm Hg) was investigated. The properties of the positive column were investigated in cylindrical tubes evacuated to $p < 5 \times 10^{-6}$ mm Hg and filled with spectrally pure gas (Ar and Ar + Cs). (M.O.W.)

9369 ACCELERATION OF ELECTRONS IN A BOUNDARY LAYER. Sigov, Yu. S. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 25-30(May-June 1967). (In Russian).

The distribution of energy between high-energy electrons and ions upon reflection from a nonhomogeneous magnetic field is calculated using the Chapman–Ferraro model. The solution is obtained in the relativistically invariant form using the Poisson equation and Maxwell's electromagnetic equations. The initial distribution function of the electrons and ions is assumed to be highly peaked and is given by delta functions. The physical characteristics of the boundary layer near the magnetic field are shown graphically, with a special emphasis on the relativistic and polarization corrections to the classical theory. The polarization correction is expressed through the coefficient α, $(\Phi^0_{\max} - \Phi_{(-)})/\Phi^0_{\max} = \alpha$, $0 < \alpha < 1$ which is found to be 0.54 in the relativistic limit. (ATD)

9370 TRANSPORTATION OF PLASMA CLUSTERS BY MEANS OF TWO-DIMENSIONAL MULTIPOLAR MAGNETIC FIELDS. Delone, G. A.; Savchenko, M. M.; Studenov, V. B. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 103-7(May-June 1967). (In Russian).

Previous studies of plasma cluster transport by two-dimensional multipolar fields with the 2s–multipolarity index equal to 4, 6, and 12 showed that, in the case of $2s = 4$, the linear motion losses depend neither on the magnetic field strength nor the distance from the gun. However, in the case in which $2s = 12$, the linear losses diminish with increasing field strength and increase with the distance from the gun. With a sufficiently large 12-polar field the plasma transport losses are practically nil up to the distance of 65 cm from the gun. An attempt is made to examine the behavior of plasma clusters injected along the axis of two-dimensional quadrupole magnetic fields and higher multipolarity fields up to 12-polar systems. (R.V.J.)

9371 DEVELOPMENT OF A TOWNSEND DISCHARGE IN N_2 UP TO BREAKDOWN INVESTIGATED BY IMAGE CONVERTER, INTENSIFIER, AND PHOTOMULTIPLIER TECHNIQUES. Doran, A. A. (Univ., Hamburg). Z. Phys., 208: 427-40 (1968).

The processes leading to breakdown in a pure N_2 discharge were studied by means of streak and shutter photography using image converter and intensifier techniques, and the results correlated with current, voltage, and photomultiplier measurements. The experiments were carried out in a plane parallel 2-cm discharge gap under pressure of 300 torr (20°C). An overvoltage of 7.56% was applied to the gap and the discharge was initiated by an uv flash which emitted ~400 electrons from a small area on the cathode. Under these conditions the initial development of the spark takes place by the Townsend mechanism. After four generations a series of luminous fronts traverse the gap, resulting in an increase in current to the ampere range, where a quasi-stable glow-like discharge forms. Each front may be associated with a local increase in field strength which is displaced through the gap, and the magnitude and form of these fields is estimated from the temporal growth in light output at different points along the axis of the discharge. It is found that distortions of typically 10 to 20% of the applied field are produced. The results of streak and shutter photographs of the processes occurring in the further transitions from the diffuse discharge to the constricted spark channel are reported. (auth)

9372 ENERGY DISTRIBUTION OF ELECTRONS FROM POINT CATHODES. Speidel, R.; Gaukler, K. H. (Univ., Tuegingen, Ger.). Z. Phys., 208: 419-26(1968). (In German).

The energy distribution of electrons from electron sources using conventional hairpin cathodes and point cathodes was measured by an electrostatic energy analyzer. With increasing beam current there was found in both cases an increasing anomalous energy broadening (Boersch effect). (auth)

9373 QUANTUM-STATISTICAL MECHANICS OF A SYSTEM OF CHARGED PARTICLES AT HIGH TEMPERATURES. Kraeft, W. D.; Kremp, D. (Univ., Rostock, Ger.). Z. Phys., 208: 475-85(1968).

If a quantum-mechanical potential is introduced the calculation of the quantum-mechanical binary distribution function for a system with Coulomb interaction is reduced to the well-known mathematical formalism of classical statistical mechanics in the case of $n\lambda^3 \ll 1$ (λ being the thermal wavelength). The two-particle quantum-mechanical potential is determined by the two-particle Slater sum. The two-particle Slater sum was calculated using an expansion according to e^2 and the resolvent formalism. From the binary distribution function the correlation energy and the free energy as well were determined up to order e^6. Symmetry effects were taken into account. (auth)

9374 CALCULATION OF THE ELECTRIC CONDUCTIVITY OF A COMPLETELY IONIZED PLASMA BY TAKING INTO CONSIDERATION THE IMPENETRATIBILITY OF THE PARTICLES. Dobbertin, Rolf (Inst. Henri Poincare, Paris). Compt. Rend., Ser. A and B, 265: 536-8(Aug. 28, 1967). (In French).

The two collision integrals recently derived (the Boltzmann integral for elastic collisions which the particles undergo when their distance is exactly the sum of their radii and a integral of collisions at a distance due to the interaction forces) are used for the calculations of the electric conductivity of a completely ionized plasma. The results obtained are compared with those of other authors. (J.S.R.)

9375 ELECTRON VELOCITY DISTRIBUTION IN A PARTIALLY IONIZED GAS UNDER THE ACTION OF ELECTRIC AND MAGNETIC FIELD. I. Lo Surdo, C. (CNEN, Frascati, Italy). Nuovo Cim. (10), 52B: 429-54(Dec. 11, 1967).

The general theory of a partially ionized gas under the action of electric and magnetic fields is investigated. Part I is devoted to the analysis of the elastic collision effects between electrons and heavy particles or electrons themselves. Neglecting the electron momentum transport due to the e–e collisions, one obtains a rather complicated integro–differential equation having the electron energy distribution function as unknown, which is solved by numerical iterative methods. Some results concerning an alkali–noble gas mixture are presented. (auth)

9376 ELECTROMAGNETIC WAVE SCATTERING BY ROTATING NONHOMOGENEOUS ELLIPSOIDAL PLASMA. Gutman, A. L. Radiotekh. Elektron., 12: 1657-60(Sept. 1967). (In Russian).

Electromagnetic wave scattering by rotating nonhomogeneous ellipsoidal plasma was studied. Coordinate systems and eikonal equations were obtained for plasma regions with "flattened" and "extended" ellipsoidal electron concentration symmetries. (R.V.J.)

9377 COLLISION TUBE STUDY OF THE STRUCTURE OF THE COLLISION WAVE BEGINNING WITH THE FLUORESCENCE OF THE GAS EXCITED BY A BEAM OF FAST ELECTRONS. Rieutord, Emile (Inst. National des Sciences Appliquees, Lyon). Compt. Rend., Ser. A and B, 265: 539-41(Aug. 28, 1967). (In French).

The density variation across a nonstationary shock wave was measured in a collision tube from the light emitted by fluorescence of the gas excited by a beam of fast electrons. The experimental results obtained for N_2 confirm the theoretical values with respect to the density ratio and to the collision wave. (tr-auth)

9378 RELEASE OF SECONDARY ELECTRONS IN LOW-PRESSURE DISCHARGES BY METASTABLE N_2 MOLECULES AND THEIR QUENCHING BY OTHER GASES. Krisch, H. (Univ., Hamburg). Z. Phys., 208: 322-37(1968). (In German).

Oscilloscopic studies of pre-breakdown discharge currents in pure nitrogen and mixtures of nitrogen with other gases show that metastable N_2 molecules influence the discharge by releasing secondary electrons when they collide with the electrodes. By this slow process an after current is produced, which lasts a time of milliseconds. It was found that the diffusion coefficient of the metastable N_2 molecule is 167 $cm^2\ s^{-1} \pm 15\%$ at 1 torr and 20°C, its radiative life time is larger than 40 ms, and its cross section for de-exciting collisions with ground-state N_2 molecules is smaller than 7×10^{-22} cm^2. There is strong evidence that the metastables are in the $A^3\Sigma_u^+$ state. From measurements in gas mixtures cross sections for de-exciting collisions with other molecules are derived. The results are for O_2 1.9×10^{-17} cm^2, for CO 1.5×10^{-17} cm^2, for H_2 2.5×10^{-20} cm^2, and for CO_2 smaller than 5×10^{-20} cm^2. (auth)

9379 QUANTUM STATISTICS OF A MANY-PARTICLE SYSTEM WITH COULOMB INTERACTIONS. Kremp, D.; Schmitz, G. (Univ., Rostock, Ger.). Z. Naturforsch., 22a: 1366-72(Sept. 1967). (In German).

The two-particle density matrix was calculated from the Bogolyubov hierarchy up to the $\underline{g}^2$ order for a system of charged particles in equilibrium. The correlation energy and the free energy up to the $\underline{g}^4$ order were determined with this function for the case $\underline{n}\lambda^3 \ll 1$. (tr-auth)

9380 HIGHER APPROXIMATIONS IN THE THEORY OF LONGITUDINAL PLASMA OSCILLATIONS. Einaudi, Franco. Ithaca, N. Y., Cornell Univ., 1967. 167p.
Thesis.

The nonlinear behavior of one-dimensional electrostatic oscillations and streaming instabilities in a homogeneous, unbounded, collisionless and fully ionized plasma is analyzed. The Vlasov–Poisson equations are solved using a singular perturbation type of analysis in which the electric field, the distribution function and the independent variable t are expanded in power series of the parameter $\epsilon = e|E_k^{(1)}|k/(m\omega_i^2)$. Here $-e$ and m are the charge and mass of the electron, $k = 2\pi/2$ is the wave number, ω_i is the damping or growth rate of the linear theory, and $|E_k^{(1)}|$ is the amplitude of the electric field given by the linear theory. Differential equations have been obtained which can be solved sequentially to obtain solutions to any order in ϵ. The series expansions derived are valid for any value of t. We have solved these equations to order ϵ^2 and applied the results to two well known problems. In the case of the Maxwellian background distribution function it is found that the changes in the real and imaginary part of the frequency are small, but that the free streaming terms go exponentially to zero as t becomes large with a damping rate proportional to ϵ^2. This contrasts with the linear case in which the free streaming terms remain undamped. For the two-stream instability problem a criterion of boundedness is proposed and is used to predict the leveling of the linear instability when $|E_k^{(1)}|$ becomes sufficiently large. Finally, the analysis allows changes in the background distribution function to be calculated, as $t \to \infty$ due to the particle–wave interaction. (Disser. Abstr.)

Production of Plasma

Refer also to abstract 9005.

9381 (CEA-R-3185) ETUDE DE L'IONISATION DE L'HYDROGENE DANS UNE DECHARGE PULSEE. (Ionization Study of Hydrogen in a Pulsed Discharge). Breton, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 3, 1967. 103p. (In French). (EUR-3438). Dep.
Thesis. Submitted to Univ. of Paris, Orsay.

The time variation of the spectral line intensities for molecular and atomic hydrogen in pulsed discharges is interpreted in terms of a model describing the instantaneous population densities of each of the species: H_2, H_2^+, H_3^+, excited atoms in a level j, electrons and protons. Every possible reaction is taken into account. For plasma diameters of about 25 cm and particle densities of the order of 10^{14} cm^{-3}, it is necessary to introduce transient line absorption coefficients. It is found experimentally that the model describes the observed phenomena reasonably well. From the calculations a method for electron temperature measurement is deduced which uses a single oscillogram giving H_β line intensity versus time. (auth)

9382 (NYO-3578-7) [PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES]. Review of Current Research Program. Progress Report. Haught, A. F. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Nov. 1967. Contract AT(30-1)-3578. 34p. Dep. CFSTI.

AEC and corporate-sponsored investigations on the production of plasma from laser-beam irradiation of solid particles are described. Various aspects of the plasma properties are discussed. (M.O.W.)

9383 (NP-tr-1605) ACCELERATION OF INHOMOGENEOUS PLASMAS BY LASER LIGHT. Hora, H.; Pfirsch, D.; Schlueter, A. Translated for Culham Lab., Abingdon, Eng., from Z. Naturforsch., 22A, 278-80(1967). 9p. (CTO-391). Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A theoretical study was made to describe the acceleration mechanisms of laser-produced plasmas. Application of the conservation theorems and nonlinear solutions of the two-fluid equations are described. (M.O.W.)

9384 SHOCK TUBE FOR STUDY OF FLOW OF IONIZED GASES. Goryachev, V. L.; Sukhov, G. S. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 3, 81-5(1967). (In Russian).

The construction of a gasdynamic shock tube, designed for the study of the flow of ionized gases in a magnetic field is described. Methods for the measurement of the basic gasdynamic characteristics of the device are given and the results of some measurements are reported. (tr-auth)

9385 ANALYSIS OF ELECTRODE HEATING ON AN ARC BURNING IN A MOVING PLASMA. Konovalov, A. E. (Central Inst. of Aircraft Engine Building, Moscow). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 135-8(Feb. 1967). (In Russian).

This is a study of the heating of "cold" copper electrodes in contact with plasma jet within the channel of a shock (gas-discharge) tube to determine the linear relationship of the heat flow to the current delivered to the electrode. The influence on cathode and anode are considered separately. The channel of the experimental assembly was made of plexiglass with a 3×4 cm^2 rectangular cross section. Plasma parameters were: velocity 2×10^6 cm/sec, conductance about 50 mho/cm, pressure 55 mm Hg, Mach number 5. Copper electrodes were used in the form of cylindrical rods 80 mm long and 2.4, 1.25, and 0.86 mm in dia. The calorimeter method was employed to measure the heat reaching the electrodes, and the value of the heat liberated on the electrode surface as a function of the current strength calculated. The voltage drop at the anode and cathode is also considered on the basis of heat flow and applied current variables. (ATD)

9386 INVESTIGATION OF THE ENERGY BALANCE OF A PLASMATRON WITH OPPOSITE JETS. Nikolaev, A. V.; Kulagin, I. D. (Inst. of Metallurgy, Moscow). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 116-19(Feb. 1967). (In Russian).

The initial results are given of a study conducted with a plasma device in which, for the purpose of achieving more intense heat exchange processes, the method of opposite jets was employed. The powdered product to be processed is introduced into two oppositely directed plasma jets. The energy balance analysis was carried out with no material for processing introduced into the jets. The plasmatron consisted of three basic units: two coaxially arranged plasma-generating heads and a jet impact chamber (reactor); each head consisted of a rod electrode (cathode), plasma gas feed section, and nozzle (anode). Tests were conducted at different argon flow rates and arc currents, with the heat transfer factor (from the plasma to the impact chamber) calculated on the basis of calorimetric measurements. The results of the reactor thermal balance analysis were worked up in the form of Nusselt and Reynolds criteria. It was also established that the plasmatron operates stably within a current range of $200 \le 1 \le 1000$ A and argon rate of $1 \times 10^{-3} \le G \le 5 \times 10^{-3}$ kg/sec (with current and flow rate summed for both heads). Within the range of plasmatron parameters tested, the heat transfer coefficient from the impacting jets to the chamber walls is 70 to 200 $W/m^2 \cdot deg$, and increases with increasing arc current and gas consumption. (ATD)

9387 NONSTATIONARY PROCESSES IN AN ELECTRIC ARC HEATER. Safronov, L. A.; Lebsak, V. L. (Central Aero-Hydrodynamic Inst., Moscow). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 102-11(Feb. 1967). (In Russian).

The transition process in the electric arc heater of an aerodynamic tube was considered. The electric arc was operating in some volume W. Gas is fed at a constant rate from one side of the chamber, and, passing through the combustion zone, it is heated to several thousand degrees, then flowing out of the chamber through the nozzle with some critical cross section F_*. During the steady state operation of the heater the flow through the nozzle G_* is equal to the input G, the pressure and temperature in the cross section are constant with time. The rapid input of energy to the gas in the chamber after arc strikes involves temperature and pressure changes in the heater as well as changes in gas flow G_* through the nozzle. The nonstationary process which occurs during the start of the heater proceeds as follows. Prior to striking the arc in the heater a certain established flow of cold gas exists. After the arc strikes the heating of some volume V of gas takes place. As a result of heating, V begins to expand and the boundary between the heated V and the cold volume V_c in the input part of the heater in the general case may first be moving towards the stream and then begin to move back towards the cross section where the arc is burning. The boundary between the heated and the cold gas in the output part of the chamber after arc strike begins to move towards the nozzle. Equations were derived and computer programs written for the calculation of three stages of the transition process. Additional calculations are carried out to determine the effect of the initial volume of the combustion zone, the choice of equation for power changes and the choice of "rest" point. (ATD)

9388 EXPERIMENTAL INVESTIGATION OF VOLTAGE FLUCTUATIONS IN PLASMATRON ARCS. Morozov, M. G.; Ivanov, V. N. (Scientific-Research Inst. of Mechanics, Moscow). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 98-101(Feb. 1967). (In Russian).

A systematic study is made of the relationship between IF voltage fluctuation in plasmatron arcs as a function of nozzle diameter, polarity, and the mean mass velocity of the gas. The experiments were conducted in a plasmatron which is a dc electric arc heater with air stabilization of the arc. The plasmatron has tubular electrodes with waterproof interiors. The voltage fluctuations in the arc were observed by means of an electronic oscillograph. The relationship between the frequency of oscillations of the arc voltage as a function of nozzle ID are shown. It is noted that the relationships obtained for the frequency of the pulsation as a function of nozzle diameter and its polarity cannot be considered universal. (ATD)

9389 THEORETICAL AND THE EXPERIMENTAL INVESTIGATIONS OF VOLT-AMPERE CHARACTERISTICS OF LITHIUM PLASMA SOURCES. Mironov, O. N. (Central Inst. of Aircraft Engine Building, Moscow). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 91-7(Feb. 1967). (In Russian).

Investigations were conducted in low-pressure plasma sources operating with lithium vapors in order to obtain generalized volt-ampere characteristics of electric arcs which operate in a vacuum. In contrast to other low-pressure plasma sources in this design lithium vapor is fed through a hollow cathode. Such a gas input into a plasma source ensures the stabilization of the cathode spot of the discharge on the inner surface of the cathode at a distance of the order of $\frac{1}{2}$ d_0 from its base. The results show that it is possible to generalize volt-ampere characteristics of the vacuum arc through the use of parameters which are valid for arcs operating at atmospheric pressure. In this case a generalization of the volt-ampere characteristic is also possible in the presence of a magnetic field, different from zero. (ATD)

9390 EXPERIMENTAL INVESTIGATION OF THERMAL FLUXES TO PLASMATRON ELECTRODES WITH GAS VORTEX STABILIZATION. Koroteev, A. S. Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 85-90(Feb. 1967). (In Russian).

Heat exchange studies between gas and electrodes were conducted on plasmatrons in which the electrodes are not cooled since in the cooled electrode it is extremely difficult to obtain thermal flux distribution along the surface. The plasmatron consisted of two copper electrodes between which the arc is fired, and a central chamber in which tangential apertures fed in the working gas (nitrogen). Thermal flux was measured by thermocouples embedded along the length of the electrode, and recorded on an N-100 oscillograph. It was found that the thermal flux distribution within the wall of the anode along its length is subdivided into (a) the region of minimal thermal flux, (b) region of maximum thermal flux, and (c) region III. In (a), the cold gas moves along the electrode and screens to a large extent the walls of the electrode from interaction with the hot masses. Region (b) is the arc region, where thermal flux from the hot gases is supplied by an additional energy due to the transfer of charged particles. In region (c), the heated working gas moves from the walls, thus transferring its energy to the electrodes. As a result, the thermal flux along the length of the electrode decreases monotonically. The distribution of thermal fluxes for different cross sections shows the temperature field in each cross section is quite nonuniform. For the cathode the results show that thermal flux distribution is significantly more nonuniform in the cathode than in the anode. The burning zone on the cathode is even more pronounced than on the anode; it is smaller. The scope of this work and the limited amount of experimental data do not warrant recommendation of any reliable empirical formula. (ATD)

9391 EXPERIMENTAL INVESTIGATION OF ELECTRIC ARC WITH VORTEX STABILIZATION IN A VARIABLE CROSS SECTION CYLINDRICAL CHANNEL. Bolotov, A. V.; Degraf, E. D. (Kazakh Polytechnic Inst., Alma Ata, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 78-80 (Feb. 1967). (In Russian).

An attempt is made to increase the voltage of a plasmatron arc. The plasmatron consists of a sequence of variable-cross-section tubular electrodes located around a single axis. The experiments were conducted with ac. The thermal efficiency of this plasmatron when the mean mass temperature coefficient of the gas stream is 800 to 1200°K, measured from the energy balance comprises 89 to 90%. After 120-hr operation the electrodes of this plasmatron showed no noticeable evidence of erosion. The relationship between the arc voltage and the internal pressure is determined. (ATD)

9392 AXIAL TEMPERATURE FIELD IN A PLASMATRON WITH VORTEX ARC STABILIZATION. Bolotov, A. V.; Zabudkina, N. G.; Tonkonogaya, L. A. (Kazakh Polytechnic Inst., Alma Ata, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 74-7(Feb. 1967). (In Russian).

The axial temperature field in a dc plasmatron with vortex arc stabilization was investigated. A special plasmatron was constructed consisting of two cylindrical electrodes with a 13-mm dia channel, separated by insulators and metallic emitters. The temperature of arc discharge was conducted spectroscopically from the relative intensity of the atomic lines of copper: 510.5, 5153.2, and 5218.2 Å. The spectra were measured on an IST-51 spectrograph with an F-270 camera using RF-3 photographic plates. The photographic exposure was varied from $\frac{1}{2}$ to $\frac{1}{200}$ sec. The axial temperature distribution along the length of the plasmatron is presented graphically. (ATD)

9393 INCREASE OF PLASMATRON OPERATING STABILITY. Zheenbaev, Zh.; Karikh, F. G.; Konavko, R. I.; Engel'sht, V. S. (Inst. of Physics and Mathematics, Frunze, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 70-3 (Feb. 1967). (In Russian).

The authors describe the design of a plasmatron having a high stability during prolonged operation and generating a plasma jet of sufficiently high temperature. The anode is made in the form of a copper cone with its vertex near the entrance to the nozzle. The cathode is a 1-mm-thick tungsten annulus placed near the nozzle edge. The nozzle consists of a set of 4-mm-thick copper diaphragms separated from one another by 0.2-mm gas gaps and rubber gaskets. The nozzle is 25 mm long, 1.5 mm in dia at the entrance and 3 mm in dia at the exit. A copper annulus protects the cathode against contact with the air. The components of the plasmatron are water cooled. The arc current is 80 to 100 A and the flow rate of the working gas (argon) is 4 to 5 liter/min. The plasmatron can operate for hundreds of hours without noticeable erosion of the electrodes. (ATD)

9394 INVESTIGATION OF DIRECT-CURRENT COAXIAL PLASMATRON. Kisel, V. S.; Uryukov, B. A.; Yadrov, V. I. (Inst. of Theoretical and Applied Mechanics, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 47-52(Feb. 1967). (In Russian).

This investigation was carried out in order to elicit the dependence of the electrical parameters of an arc in a coaxial plasmatron on the magnitude and topology of the magnetic field and gas dynamic parameters. Furthermore, one of the problems was to check the possibility of stable operation of a plasmatron (without breakoff of the arc) at high velocities of the gas flow incident to the arc. A coaxial plasmatron with water-cooled copper electrodes was investigated. The gas being heated was air, which was delivered into the interelectrode cavity without twisting, and rotation of the arc was accomplished by the magnetic field of a solenoid placed on the plasmatron. The experiments were carried out with free discharge of air into the atmosphere. The effect of the velocity of blowing on the characteristics of the arc was studied in the range of air flow rates from 2.7×10^{-3} to 8.0×10^{-2} kg/sec. Stable operation of the plasmatron was observed in this entire range. The character of the change of current and voltage across the arc upon a change of axial velocity of the flow was found to depend both on the polarity of the electrode connection and on the magnetic field strength in the arc-burning zone. At air flow velocities up to 4.8 m/sec and with forward polarity, the phenomenon of low-frequency (0.1 to 0.5 Hz) reciprocating motion of the arc in an axial direction attended by rather rigorously periodic fluctuations of the current and voltage was detected. This phenomenon was observed only in the case of forward polarity, this process not arising in the presence of reversed polarity in the investigated range of flow velocities and position of the magnet. (ATD)

9395 GENERALIZED CHARACTERISTIC OF A SECTIONAL ELECTRIC-ARC GAS HEATER WITH A VORTEX-STABILIZED ELECTRIC ARC. **Stel'makh, G. P.; Chesnokov, N. A.; Sologub, V. A. Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 45-6(Feb. 1967). (In Russian).**

The experiments were carried out on a nine-section plasmatron, during which the current strength, flow rate of gas (argon), and channel length were varied. The range of investigated values lay within I = 100 to 1000 A, U = 30 to 150 V, and G = 1 to 6 g/sec. The distance from the edge of the lower section to a tungsten cathode was taken as the length of the channel. The experiments showed that with a decrease of the ratio of the channel length to its diameter the slope of the curves decreases, i.e., the rate of increase of the volt–ampere characteristics drops. When this ratio is less than or equal to unity there is a tendency toward the formation of a decreasing volt–ampere characteristic. (ATD)

9396 HEAT CHARACTERISTICS OF A PLASMA GENERATOR. **Shorin, S. N.; Troitskii, V. N.; Smorodin, A. I. (Moscow Inst. of Chemical Machine Construction). Izv. Sib. Otd. Akad. Nauk SSSR, No. 3, Ser. Tekh. Nauk, No. 1, 41-4(Feb. 1967). (In Russian).**

An investigation was made of the heat characteristics of a dc plasma generator with an argon-stabilized arc, the length of which was self-adjusting. The anode was a water-cooled copper nozzle and the cathode a tungsten rod, the holder of which was also water-cooled. The argon flow rate was varied from 1 to 10 m^3/hr and the electrical power from 1 to 30 kW with a change of current from 50 to 600 A. The experimental investigations showed that electron transfer of energy at the anode spot makes the main contribution to total heat transfer to the wall. In this case local heat fluxes exceed many times the average. The relative heat losses at the cathode constituted a negligible part of the power input. Although these losses were taken into account in this investigation, for practical calculations of the investigated type of plasma generators heat losses at the cathode can be disregarded with an error not exceeding 5%. (ATD)

Stability of Plasma

Refer also to abstract 9308.

9397 PLASMA INSTABILITY AND CONTROLLED THERMONUCLEAR REACTIONS. **Kadomtsev, B. B. Usp. Fiz. Nauk, 91: 381-7(Mar. 1967). (In Russian).**

The magnetohydrodynamic instabilities in which macroscopic sections of the plasma are displaced with velocities on the order of the thermal ion velocity v_i are the most dangerous, but they are also relatively easy to stabilize. Thus, the spiral instability is eliminated by superimposing a strong longitudinal magnetic field. Flute instabilities can be eliminated by the presence of a magnetic surface with crossed force lines. Drift instabilities are not subject to complete stabilization, but can be modified. Drift instabilities exist only if the phase velocity along the magnetic field exceeds the thermal ion velocity. In the presence of crossed force lines the oscillations become strongly localized in the radial direction. Thus these instabilities can be suppressed if there are closed magnetic surfaces in the plasma. In order to attain controlled thermonuclear fusion it is necessary to overcome the enormous technical problems associated with the creation of a magnetic field on the order of 10^5 oersteds with the use of superconducting alloys in a volume of cubic meters. (TTT)

9398 MACROSCOPIC QUASI-LINEAR THEORY OF THE TWO-STREAM INSTABILITY. **Voelk, Heinrich J. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 10: 2629-33(Dec. 1967).**

The quasi-linear development of the instability of two counter-streaming electron beams is discussed from a hydrodynamic point of view. While it turns out that the closure assumptions for the system of moment equations have an appreciable influence on the time asymptotic result, the nonresonant diffusion mechanism allows a number of interesting interpretations in the fluid picture. (auth)

9399 OBSERVATION OF A BALLOONING-TYPE INSTABILITY IN A PLASMA CONFINED BY A QUADRUPOLE MAGNETIC FIELD. **Meade, D. M.; Yoshikawa, S. (Princeton Univ., N. J.). Phys. Fluids, 10: 2649-52(Dec. 1967).**

Instabilities of a ballooning type were observed in the $\oint dl/B$ stable region of a linear quadrupole device. The amplitude distribution of the fluctuation along a field line behaved like a standing wave that had a node where $\nabla B^2 \cdot \nabla p < 0$ and was peaked where $\nabla B^2 \cdot \nabla p > 0$. The quantity $k_{11}\lambda_{mfpe}$ was typically 5 to 10. The observed fluctuation is in qualitative agreement with the theory of collisionless drift waves modified to take into account the change of field curvature and field strength along the field line. The threshold for the instability appears to be strongly dependent on the ratio of the plasma radius to connection length. The plasma confinement was not sensitive to the presence of the ballooning instability. (auth)

9400 EFFECT OF A HIGH-FREQUENCY SPATIALLY UNIFORM EXTERNAL ELECTRIC FIELD ON A PLASMA. **Prasad, R. (Bengal Engineering Coll., Howrah, India). Phys. Fluids, 10: 2642-8(Dec. 1967).**

Dispersion relation for transverse waves in a fully ionized plasma in the presence of a spatially uniform field $E_0 \cos \nu t$ has been obtained and the possibility of instabilities has been discussed. It has been shown that the analysis also gives the Dawson–Oberman formula for the force of an ion on the electrons for the uncoupled longitudinal field. (auth)

9401 STABILITY OF A DENSE PLASMA CONFINED BY A ROTATING MAGNETIC FIELD. **Troyon, Francis (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Phys. Fluids, 10: 2660-74(Dec. 1967).**

The stability of a dense plasma (negligible skin depth) confined by a rotating magnetic field which is parallel to the surface is analyzed for plane and cylindrical geometries. This analysis culminates in an integrodifferential equation for each mode of deformation. Specific properties of the plasma enter only through the normal acoustic impedance. The concept of average stability is introduced. Very general restrictions on the acoustic impedance of the plasma are introduced which allow the derivation of various stability criteria. These criteria are applied to different cases of interest. The plasma is described successively by a fluid model and a free particle model. Numerical estimates of the frequency needed to achieve stability for each mode are given. (auth)

9402 STUDIES OF THE HELICAL INSTABILITY.OF PLASMA IN HELIUM–OXYGEN MIXTURES. **Efendiev, K. I.; Dashdamirov, K. M. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 2, 97-9(1967). (In Russian).**

Studies were made of the helical instability of plasma in helium–oxygen mixtures in a longitudinal magnetic field. The critical value was determined for the magnetic field in which the instability takes place at various oxygen contents of the mixture. The transition of the positive cylinder into a helical instability is usually accompanied by characteristic noises with a rapid change in the longitudinal gradient of the potential of the density current on the wall, and the discharge current. (R.V.J.)

9403 STABILITY OF THE SKIN LAYER IN A PLASMA WITH COLLISIONS. **Mikhailovskii, A. B.; Sidorov, V. P. Zh. Tekh. Fiz., 37: 1630-40(Sept. 1967). (In Russian).**

The quasihydrodynamic approximation used to describe the motion and stability of an inhomogeneous plasma in the presence of a constant magnetic field and a high-frequency electromagnetic field consisting of two traveling waves with different but comparable frequencies propagating in the same direction perpendicular to the magnetic field. The calculations are performed for a case of plane symmetry, but in the contemplated applications to cases of axial symmetry the high-frequency waves would propagate in the aximuthal direction. It is assumed that the electron–ion collision frequency is higher than the frequency of the high-frequency field, and there are treated only perturbations having frequencies much lower than the frequency of the high-frequency field. The equation of motion of the electrons is simplified by neglecting the high-frequency motions of the ions and powers of the ratio of the high-frequency field frequency to the collision frequency, and averaging out the high-frequency motions of the electrons. The resulting force on the electrons due to the presence of the high-frequency field is found to vanish in case there is only one traveling wave, owing to the fact that the electrons become accelerated to the phase velocity of the waves. The thermal motions of the ions are neglected. A dispersion equation is derived from these equations of motion and its roots are discussed. It is found that potential oscillations with wavelengths shorter than the thickness of the collision skin layer are unstable, but growth times between the period of the high-frequency field and the ion entrainment time. Flute instability and drift-dissipative instability persist in the presence of the high-frequency field. This is due to the fact that the force exerted by the perturbed high-frequency field is analogous rather to a tensor friction force than to a gravitational force. (ATD)

9404 PLASMA STABILITY IN COMBINED MAGNETIC FIELDS. Kogan, E. Ya.; Moiseev, S. S.; Oraevskii, V. N. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 12-15(May-June 1967). (In Russian).

Toroidal-type plasma systems and instabilities typical of rapidly oscillating corrugated fields were studied. The influence of the intersection of magnetic field lines on plasma stability was also considered. Employing the variational approach to the basic equation, the results of Furth et al. (Phys. Fluids, 6: 459(1963)) were obtained in simpler fashion. Further analysis led to the equation describing the oscillation modes developing in drift waves in the presence of dissipation factors (drift dissipative mode) and in the presence of gravitational potential (gravitational dissipative mode). Its finite solution corresponds to the aperiodic instability with a given increment also obtained by Furth (Lecture Notes at the International Centre for Theoretical Physics, Plasma Physics, 1964). In connection with the stabilizing properties of systems with nonparallel field lines, the authors stress the importance of the plasma stability investigation for the oscillation frequencies $\omega < k_z v_{ti}$ (k_z = wave vector along the z-axis and v_{ti} = ion thermal velocity). It is stated that in this frequency range only one instability has been found, notably $\partial \ln T_0 / \partial \ln \eta_0 > 2$ ($T_0(x)$ = temperature, $n_0(x)$ = density of the inhomogeneous along the x plasma). This and the existing belief about the stabilizing effect of Landau damping on ions strengthen the case for plasma stability for short, longitudinal waves. However, the existence of an instability of sufficiently universal type which develops at short wavelengths is demonstrated. (ATD)

9405 INTEGRATION OF THE PERTURBED VLASOV EQUATION IN A REDUCED PHASE SPACE. Sestero, A. (EURATOM-CNEN, Frascati, Italy). Nuovo Cim. (10), 52B: 567-9(Dec. 11, 1967).

The integration procedure is shown. (M.O.W.)

9406 DIFFUSION AND INSTABILITIES OF A HIGH-FREQUENCY PLASMA IMMERSED IN A UNIFORM LONGITUDINAL MAGNETIC INDUCTION. Vacquie, S.; Benoit-Cattin, P.; Bordenave-Montesquieu, A.; Serrot, G. (Faculte des Sciences, Toulouse). Nuovo Cim. (10), 52B: 403-10(Dec. 11, 1967). (In French).

An experimental study was made of the evolution of charged particle diffusion and spatial distribution inside the discharge and of the radial electric field vs. magnetic-induction values higher than critical induction. The existence range of the microinstabilities is determined, their evolution with various parameters is studied. Under certain circumstances the maintenance of these oscillations is performed by an anisotropy of the velocity-distribution function. (auth)

Thermonuclear Processes

9407 TECHNOLOGY OF FUSION POWER. Carruthers, R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). New Sci., 36: 642-4(Dec. 14, 1967).

Although the conditions for generating power from controlled nuclear fusion have not yet been attained, the author discusses the form that a power station based on this energy source would take, and arrives at a rough idea of its costs, as a guide for present-day research. (auth)

Shielding

Refer also to abstracts 8378, 9129, 9534, and 9916.

9408 (DAC-60659) SOBER, A MONTE CARLO PROGRAM FOR NEUTRON AND GAMMA RAY TRANSPORT IN COMPLEX GEOMETRIES. Jordan, T. M. (Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.). May 1967. 138p. Dep.

SOBER, a Monte Carlo code for neutron and gamma ray transport calculations in generalized geometries is described. A number of unique analytical methods and numerical techniques have been developed at Douglas for Monte Carlo solution of the stationary energy-dependent Boltzmann equation. New analytical methods described include: (1) the consistent use of energy-independent biasing functions in the random selection of position and direction vectors; (2) the use of energy-dependent packets, with each packet representing a multitude of the mono-energetic particles utilized in other applications of the Monte Carlo method; (3) analytic integration of the energy-dependence of the integral equation for scattered source densities; and (4) a technique for estimating optimum values of adjustable parameters in the biasing functions, based on partial derivatives of the coefficient of variation. Numerical techniques, including those used to implement the above analyses, include: (1) a simplified procedure for describing the independent source; (2) a treatment of quadric surface geometries which eliminates the major difficulties associated with generalized geometries; (3) the use of multigroup constants for neutron transport calculations coupled with an exact treatment of the angular dependence of scattering by hydrogen; (4) the use of the exact Klein-Nishina equation for gamma ray scattering by free electrons; (5) the generation of Legendre coefficients describing angular fluxes, rather than tabulating the fluxes between angular limits; and (6) analytic estimation of angular flux moments for volume, quadric surface, and point detectors. (auth)

9409 (NAA-SR-Memo-12467) NEUTRON AND GAMMA RAY ATTENUATION IN SODIUM SHIELDS. Thiele, A. W. (Atomics International, Canoga Park, Calif.). June 30, 1967. Contract AT(04-3)-701. 36p. Dep. CFSTI.

Measurements of the neutron and gamma attenuation in sodium, and calculations of the expected neutron attenuation using Monte Carlo and moments method solutions to the Boltzmann transport equation were made. (M.O.W.)

9410 (ORNL-4192) THE ELECTRON-PHOTON CASCADE INDUCED IN LEAD BY PHOTONS IN THE ENERGY RANGE 15 TO 100 MeV. Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 31p. Dep. CFSTI.

Electron-photon cascade calculations have been carried out for photons of energy 15, 25, 35, 45, 60, and 75 MeV incident on a semi-infinite slab of lead of 3 radiation lengths' thickness and for photons of energy 100 MeV incident on a slab of lead of 15 radiation lengths' thickness. The results obtained include the energy deposition as a function of depth in the slab and the energy and angular distributions of the transmitted photons and charged particles. (auth)

9411 ENERGY AND DOSE BUILDUP FACTORS FOR VARIOUS CONCRETES. Clark, F. H.; Trubey, D. K. Nucl. Appl., 4: 37-41(Jan. 1968).

Buildup factors have been determined by moments method calculations for ordinary, magnetite, and baryte concretes. They agree well with approximate evaluations in the range 3 to 6 MeV. Outside that range there is noticeable disagreement. (auth)

9412 ATTENUATION OF CHARGED PARTICLES. pp 151-77 of Radiation and Shielding in Space. Haffner, James W. New York, Academic Press, 1967.

The attenuation of charged particles in space is attributed to ionization, radiation, and nuclear interactions. Each is briefly described. 55 references. (M.O.W.)

9413 UNCHARGED RADIATION ATTENUATION. pp 178-214 of Radiation and Shielding in Space. Haffner, James W. New York, Academic Press, 1967.

Discussions are presented on the following: (1) neutron interactions with matter, (2) gamma-ray interactions with matter, (3) neutron attenuation in matter, (4) x and gamma ray attenuation in matter, and (5) radiation scattering. 72 references. (M.O.W.)

9414 SPACE RADIATION SHIELDING COMPUTER CODES. pp 215-52 of Radiation and Shielding in Space. Haffner, James W. New York, Academic Press, 1967.

A general discussion on the use of computers for space shielding calculations is given. Brief descriptions of a few codes are given. 47 references. (M.O.W.)

9415 DOSES DUE TO NUCLEAR SPACE RADIATION. pp 253-98 of Radiation and Shielding in Space. Haffner, James W. New York, Academic Press, 1967.

Spacecraft shielding is discussed with respect to solar flares, trapped radiation, and galactic radiation. Earth shielding is discussed in terms of atmospheric effects, magnetic field effects, and combined atmospheric-geometric effects. 47 references. (M.O.W.)

9416 MISSION ANALYSIS CONSIDERATIONS. pp 299-325 of Radiation and Shielding in Space. Haffner, James W. New York, Academic Press, 1967.

Discussions are presented on the following: (1) mission timing, (2) doses on Earth orbital missions, (3) deep space missions, (4) shield weight considerations, optimization, (5) dose reduction via operational procedures, and (6) other shielding concepts. 42 references. (M.O.W.)

9417 LAMINATED RADIATION RESISTANT PANELS. van Wagoner, Mark Bellaire; Testaguzza, Gino. British Patent 1,093,452. Dec. 6, 1967. Filed Mar. 25, 1965.

The radiation-resistant panels each consist of two layers. The first layer is made up of a polyester or epoxy resin, sand, and asbestos cement. The second layer includes in its composition lead and at least one layer containing a fiberglass fabric. The panels may be made up as a sandwich of a sheet of lead between two outer layers comprised of fiberglass impregnated with a polyester or epoxy resin, sand, and asbestos cement. The two outer layers may also include powdered lead in their composition. (B.L.M.)

Solid-State Physics

Refer also to abstracts 8781, 8782, 9072, 9077, 9098, 9103–9108, 9111–9114, 9116, 9254, 9921, 9982, and 10142.

9418 (CEA-Bib-99) LA CANALISATION APPLIQUEE A L'ETUDE DES DEFAUTS. (Channeling Applied to the Study of Defects). Genthon, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 33p. (In French). Dep.

The channeling effects of fast charged particles passing through crystals have been used since 1966 for studying crystal defects. Transmission effects and effects due to change in the amount of short distance reactions together with blocking effects have been used by different authors to measure, to detect, and even to localize different types of defects in the crystal or even in the crystal lattice. This very general and very promising technique should soon be improved beyond the qualitative stage. (auth)

9419 (COO-623-120) SOLID STATE PHYSICS PROGRAM. LOW TEMPERATURE THERMAL EXPANSION COEFFICIENT OF SODIUM FLUORIDE. Technical Report No. 46. Loje, Kenneth F. (Case-Western Reserve Univ., Cleveland, Ohio). May 1967. Contract AT(11-1)-623. 24p. Dep. CFSTI.

The linear thermal expansion coefficient, α, for sodium fluoride was measured between 40 and 280°K using a single-crystal, back-reflection x-ray technique. The results are compared with the recent work of James and Yates. A room-temperature value of the Gruneisen parameter, $\gamma = 3\alpha VB_s/C_p$, is calculated and compared with the value obtained by Miller from classic constant measurements. (auth)

9420 (COO-623-127) SOLID STATE PHYSICS PROGRAM. Annual Progress Report. (Case-Western Reserve Univ., Cleveland, Ohio). Nov. 1, 1967. Contract AT(11-1)-623. 21p. Dep. CFSTI.

Work still in progress on the following subjects is described briefly: torque magnetometer measurements, preparation of thin films for Moessbauer measurements, epitaxy of Cu, Ni, and Al on [111] Si, precision measurement of surface lattice constants, temperature and pressure derivatives of the dielectric constants of the alkali metal halides and alkaline earth fluorides, and theoretical calculations concerning the magnetic properties and lattice dynamics of solids. Technical reports and published papers on completed work are listed, and abstracts are included. (A.G.W.)

9421 (COO-1284-6) EPR STUDIES OF TITANIUM INTERSTITIALS IN N-TYPE RUTILE. Kingsbury, P. I.; Ohlsen, W. D.; Johnson, O. W. (Utah Univ., Salt Lake City). Sept. 2, 1967. Contract AT(11-1)-1284. 6p. (CONF-670951-2). Dep. CFSTI.

From American Institute of Physics Summer Meeting, Seattle, Wash.

A detailed study was made of the four-line spectra to study the defect structure of rutile. The results are discussed. (M.O.W.)

9422 (EGG-1183-2151) INFRARED IMAGING OF HEATED EFFLUENTS: A PHOSPHOR RESPONSE STUDY. Final Report. Technical Report Number S-388-R. Lynn, R. L. (EG and G, Inc., Santa Barbara, Calif.). July 1967. Contract AT(29-1)-1183. 38p. Dep. CFSTI.

A series of luminescent de-excitation experiments to evaluate several classes of phosphors having electroluminescent and thermoluminescent properties are described. The purpose of the measurements was to determine whether these phosphors could be used as infrared-to-visible-light converters based on infrared-stimulated luminescent de-excitation of energy states in the phosphors that had been previously excited by ionizing radiations. The overall purpose has been to develop a capability for long-wavelength (infrared) imaging of cool effluent sources. The techniques used in making the measurements and the resulting data are presented. The results of the experiments have been generally negative. (auth)

9423 (JINR-P14-3608) VOZMOZHNOSTI PRIMENENIYA EFFEKTA MESSBAUERA V FIZICHESKIKH ISSLEDOVANIYAKH PRI SVERKHNIZKIKH TEMPERATURAKH. (Possibilities of Applying the Moessbauer Effect in Physical Investigations at Superlow Temperatures). Khennig, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 19p. (In Russian).

Already published papers and common recommendations for further investigations such as absolute temperature measurements, observation of depolarization induced by K capture, investigation of relaxation effects, and determination of local moments of paramagnetic admixtures in nonmagnetic metals are reviewed in this paper. (auth)

9424 (ORNL-TM-2023) OPTICAL PROPERTIES OF VACUUM-EVAPORATED FILMS OF TELLURIUM AND AMORPHOUS SELENIUM. Hayes, J. D. Jr.; Arakawa, E. T.; Williams, M. W. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 52p. Dep. CFSTI.

Thesis. Submitted by James David Hayes, Jr. to Vanderbilt Univ., Nashville, Tennessee.

Optical constants were obtained for the films in the ultraviolet spectral region. The optical constants were used to calculate the real and imaginary parts of the complex dielectric constant and the volume- and surface-plasma energy loss functions. (M.O.W.)

9425 (RPI-1995-7) ENERGY LEVEL STRUCTURE OF ZINC IN MAGNETIC FIELDS USING A SINGLE BAND EFFECTIVE HAMILTONIAN. Kapo, Peter S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Dec. 1967. Contract AT(30-1)-1995. 131p. Dep. CFSTI.

Thesis.

The midplane of the second band in zinc is computed by means of the nearly free electron approximation. This band is Fourier analyzed and the coefficients, $\epsilon(\vec{R})$, are used to construct the magnetic effective Hamiltonian $E(\vec{\Pi}) = \Sigma_R \epsilon(\vec{R})\exp(i\vec{R}\cdot\vec{\Pi}/\hbar)$ $[\Pi = \vec{p} + e\vec{A}/c]$. This effective Hamiltonian is cast into the form of a matrix equation and the eigenvalue spectrum computed by numerical means for a range of magnetic fields. The eigenvalue spectrum found is compared with the Onsager rule and systematic deviations from the Onsager rule are noted. The fine structure of the magnetic bands is computed by a WKB method and these results are compared with the actual band structure. Certain deviations in the fine structure occur which can not be eliminated by further refinement of the WKB method, showing a failure of the WKB method in this respect. (auth)

9426 (SC-RR-67-66) LAPLACE TRANSFORM ANALYSIS OF THIN PIEZOELECTRIC PLATE CONFIGURATIONS. Stuetzer, O. M. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 49p. Dep. CFSTI.

The open- and short-circuit transient behavior of thin piezoelectric elements is analyzed for three geometries. The elements are arranged between matched lines, at the end of a matched line, or are mechanically free. Linear dependence of mechanical and electrical stresses and displacements is assumed, as is unidimensional strain. Otherwise, the treatment is rigorous. Operational calculus is used. Electromechanical cross coupling and dependence on both electrical and mechanical boundary conditions make the analysis involved. For short-circuit operation, sizable deviations from results obtained by elementary approximations are found. Mechanical or electrical step initiation of short-circuited elements generates exponential current and stress pulses. Transit of an originally rectangular stress pulse through a shorted piezoelectric element produces precursors. Twenty-two examples are analytically described in detail. They are intended to represent a systematic compilation of solutions which are needed most often in the theory of dynamic pressure gauges, acoustic pulse generators, electromechanical code transmitters, and for interpretation of dynamic measurements. (auth)

9427 (TID-24201) HIGHLIGHTS OF TECHNICAL PROGRAMS/1966. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. 191p. Dep. CFSTI.

Brief summaries of research are presented on various aspects of the following: (1) contamination control, (2) dynamic response of materials and structures, (3) radiation physics, (4) ferroelectrics, (5) Joint Task Force Two, (6) aerospace research, (7) explosive geophysics, (8) mathematics, (9) physics, (10) chemistry, (11) aerothermodynamics, (12) engineering technology, (13) device and instrument development, and (14) manufacturing technology. (M.O.W.)

9428 (YALE-2560-18) X-RAY STUDY OF THE STRUCTURE OF LIQUID METALS AND ALLOYS. Annual Progress Report, January 1–December 31, 1967. Wagner, C. N. J. (Yale Univ., New Haven, Conn. Dept. of Engineering and Applied Science). Contract AT(30-1)-2560. 7p. Dep. CFSTI.

Brief discussions are presented on the following: (1) partial interference and atomic distribution functions of liquid silver–tin alloys, (2) predicted resistivities of silver–tin alloys, (3) partial interference functions of liquid gold–tin alloys, (4) structures of liquid mercury and dilute mercury alloys, and (5) x-ray diffraction study of the structure of vapor-quenched and liquid Ag–52 at. % Cu alloys. (M.O.W.)

9429 (AERE-Trans–1075) WAVE-MECHANICAL CALCULATION OF THE SCATTERING OF NEUTRONS BY MAGNETISED CRYSTALS. Doering, W. Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Angew. Phys., 20: 311-17(1966). 20p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The scattering of neutrons by magnetised crystals is calculated on the assumption that the induction in the scatterer is a given function of time and position. This assumption, which is not really valid for inelastic scattering, causes only a slightly incorrect factor in the absolute value of the intensity in scattering with emission of magnons. The error is of no practical importance, and the advantage is that the calculation can be made without any assumptions regarding the Hamiltonian operator of the magnetised substance. The time average induction determines the elastic scattering; the oscillations of magnetisation cause inelastic scattering. The formulae for the intensity and polarisation of the scattered neutrons as functions of the directions of magnetisation and polarisation of the incident neutrons, previously derived only for the Heisenberg model, are re-derived in a simpler manner. It is shown that the observed dependence on the direction of polarisation is not a function of the interaction between magnetic moments, but is governed only by the precession of the electron spins and the direction of their rotation. The calculations are generalised to the case where the precession describes a cone of elliptical cross section. (auth) (UK)

9430 THERMOELECTRIC PROPERTIES OF ALLOYS OF NIOBIUM WITH TITANIUM OR HAFNIUM. Druzhinina, I. P.; Fraktovnikova, A. A.; Vladimirskaya, T. M. Izmer. Tekh., No. 10, 41-2(Oct. 1967). (In Russian).

Results showed that these alloys can be used as thermoelectric materials for work in vacuum and inert gas atmosphere at temperatures from 1500 to 1700°C. In temperatures up to 1700°C the Nb alloys containing up to 20% Ti and 10% Hf have stable thermoelectric properties. The alloys can be used for fine wires of diameter of 5 μm. (tr-auth)

9431 INVESTIGATION OF THE RADIATION PROCESSES IN IONIC CRYSTALS. Shvarts, K. K.; Plyavinya, I. K. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 17-31(1967). (In Russian).

The results of scientific investigations in ionic crystal radiation physics carried out at the Institute of Physics of the Academy of Sciences of the Latvian SSR during the last five years are surveyed. The formation of radiation defects in LiF and other alkali metal halide crystals were studied for dependence on temperature, on the presence of impurities, and on the kind and the absorbed dose of ionizing radiation. The formation processes of clusters and other defects have also been studied. The results of the investigation in the activator luminescence kinetics in homological rows of alkali halide crystals, activated by Hg-like ions are cited. These investigations have disclosed the energetic microstructure of the centers and the processes of fluorescence (the excitation in the bands of activator), and also some details of the mechanism of energy transfer from the lattice and from the color centers to the activator. The results of the temperature dependence of radioluminescence yield under the excitation by the radiation with different ionization density is also discussed. The results for applying the alkali metal halide crystals in dosimetry are presented. (auth)

9432 RADIATION HEATING OF LITHIUM FLUORIDE CRYSTALS DURING THE PROCESS OF IRRADIATION IN THE REACTOR. Vitol, A. Ya.; Kalnin, D. O.; Lyushina, A. F.; Shvarts, K. K. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 66-71(1967). (In Russian).

Radiation-induced heating in pile-irradiated LiF crystals (^{6}Li content 2.7%) and its dependence on thermal neutron flux, sample dimensions, and cooling conditions were studied. Experimental results are compared with calculations. The influence of radiation-induced heating on dosimetry applications is discussed. (auth)

9433 STUDY OF METALLIC LITHIUM COLLOIDS IN PILE-IRRADIATED LiF CRYSTALS. Ekmanis, Yu. A.; Eglite, G. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 62-5(1967). (In Russian).

Distributional characteristics of colloidal particles of lithium on the surface and in the volume of LiF crystals irradiated in a reactor with doses from 10^{18} to 10^{19} neutrons/cm^2 were investigated by electron microscopy. It was found that the processes of forming macrodefects and the colloidal lithium particles are related. (auth)

9434 RADIOLUMINESCENCE OF LiF–U. Aluker, E. D.; Intenberg, L. E.; Podin, A. V.; Chernov, S. A. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 58-61(1967). (In Russian).

The temperature dependence of radioluminescence of LiF–U on varied activator concentration at excitation by x rays and by pile radiation was measured. (auth)

9435 KINETICS OF RADIOCOLOURATION AND RADIOLUMINESCENCE OF ALUMINOPHOSPHATE GLASSES. Novotny, J.; Spurny, Z. (Nuclear Research Inst., Prague). J. Phys. Chem. Solids, 28: 1927-32(Oct. 1967).

The kinetics of x-ray induced coloration of aluminophosphate glasses was studied. Three absorption bands were found, namely at 3.35, 2.35 and 1.93 eV. The fluorescence and thermoluminescence curves of these glasses were established and the species corresponding to fluorescence, phosphorescence, thermoluminescence and color centers determined. (auth) (UK)

9436 RELAXATION AND DYNAMIC POLARIZATION BY PARAMAGNETIC IMPURITIES. Abragam, A. (College de France, Paris. Commissariat a l'Energie Atomique, Paris); Kirsch, J. pp 365-411 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Topics covered are: quantum statistical mechanics, relaxation and dynamic polarization in liquids, spin temperature, electron–nuclear interaction in metals, fixed paramagnetic impurities, dynamic polarization, polarized targets and possible new target materials. 38 references. (M.H.R.)

9437 CONDUCTION ELECTRON CHARGE AND SPIN DENSITY EFFECTS DUE TO IMPURITIES AND LOCAL MOMENTS IN METALS. Watson, R. E. (Brookhaven National Lab., Upton, N. Y.). pp 413-65 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

The perturbation of conduction electron charge and spin densities due to local magnetic moments is discussed. In the charge case Knight shifts in solid and liquid alloys are concentrated on and the associated quadrupole interaction problem is only briefly inspected. The spin density perturbations have magnetic hyperfine fields directly associated with them and the information gained by Moessbauer effect and other means are discussed. 62 references. (M.H.R.)

9438 NUCLEAR MAGNETIC RESONANCE IN SOME MAGNETICALLY ORDERED SYSTEMS. Budnick, J. I.; Skalski, S. (Fordham Univ., New York). pp 724-36 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

Experimental procedure for the spin–echo technique in NMR work is described briefly. Results are presented on several systems: (1) ferromagnetic solutions of Fe in Pd; (2) Fe-rich solid solutions; (3) ordered ferromagnetic Fe_3Si; and (4) Laves-phase compounds of Gd. (M.H.R.)

9439 RELATION BETWEEN *g* SHIFT OF MAGNETIC IMPURITIES AND KNIGHT SHIFT OF THE HOST NUCLEI IN METALS. Shaltiel, D. (Hebrew Univ., Jerusalem). pp 737-44 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

The ^{139}La NMR was measured in eleven Laves phase compounds of the type $La_{1-x}Th_xRu_2$ $(0 < X < 1)$ as a function of temperature. The ESR of one mole percent of Gd added as impurity in place of La in compounds of the same composition were studied at 20°K. It is concluded that the relation between the *g* shift and the Knight shift can be used to evaluate some properties of the metal with the rigid band model in addition to those properties obtained from independent measurements of the *g* shift and Knight shift. (M.H.R.)

9440 CHANGES IN THE PARAMETERS OF COLOR CENTERS PRODUCED BY RADIATION AND MECHANICAL FACTORS. Davitashvili, T. Sh.; Politov, N. G. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 829-31(May 1967). (In Russian).

The formula $E = A(R) - B(R)\coth[hf(R)/2kT]$ is used to calculate the effects of temperature and hydrostatic pressure on the position of the F absorption band in KCl crystals, and the results are compared with experimental data on the effect of neutron irradiation on the F band in KCl. In the formula, E is the position of the band; R is the "defect parameter," defined as the distance from the center of the anion vacancy to the center of the nearest lattice ion; f is the phonon frequency; h, k, and T have their usual meanings; and the quantities A and B, like f, are independent of T. It was found that neutron irradiation increases A, B, and f, and decreases R. Both hydrostatic pressure and neutron irradiation increase the quantities A, B, and f; in the case of hydrostatic pressure, however, the increase in A is predominant, whereas in the case of neutron irradiation, the increases in B and f are also large. The parameters B and f characterize the interaction of the F-center electron with the lattice vibrations; it is accordingly concluded that neutron irradiation produces significant changes in this interaction. (ATD)

9441 CONCERNING THE CONVERSION OF X-RAY ENERGY IN EUROPIUM-ACTIVATED ALKALI METAL HALIDE CRYSTALS. Parfianovich, I. A.; Shuraleva, E. I.; Ivakhnenko, P. S. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 832-4(May 1967). (In Russian).

The F-band stimulated photoluminescence and the roentgenoluminescence of europium-activated NaCl, KCl, KBr, and KI crystal phosphors were investigated. The F-band stimulated photoluminescence of these phosphors was found to be associated with a recombination process, probably electronic. The phosphors were x irradiated at 90°K, subsequently heated to some temperature T, and cooled again to 90°K, after which their roentgeno- and photoluminescence intensities were measured. The heating increased both the roentgeno- and photoluminescence intensities in a similar way, the increase being greatest when T had some optimum value between about 200 and 300°K, depending on the host crystal. Because the heating could not increase the F-center concentration, it is concluded that there takes place a redistribution of holes from traps in the host crystal to activator centers and that the roentgenoluminescence is due to recombination of free electrons with holes trapped near the luminescence centers. The phosphors were also x irradiated at different temperatures (up to about 700°K) and the roentgeno- and photoluminescence intensities and the F-center concentration were measured at the irradiation temperature. High roentgenoluminescence intensities at low (100 to 150°K) temperatures in NaCl : Eu and KI : Eu are ascribed to excitation of ionic activator centers by ultraviolet radiation resulting from recombination of electrons with V_k centers. Considerable roentgenoluminescence yields were observed at higher temperatures than those at which, according to absorption and excitation spectrum data, there can exist stable hole-activator centers. It is suggested that either the recombination losses decrease sharply with increasing temperature, or there comes into play a new mechanism for the transfer of energy from the host lattice to the luminescence centers. (ATD)

9442 EFFECT OF IONIZING RADIATION ON IMPURITY CENTERS IN EUROPIUM-ACTIVATED ALKALI METAL HALIDE PHOSPHORS. Parfianovich, I. A.; Ivakhnenko, P. S.; Shuraleva, E. I. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 835-8(May 1967). (In Russian).

Absorption curves of europium-activated NaCl, KCl, KBr, and KI crystals after x irradiation at different temperatures from 93 to 400°K revealed the presence of a number of induced activator absorption bands, in addition to the α, β, V_2, V_3, V_4, V_k, F, and M bands of the host color centers. These induced activator absorption bands were strongest at certain temperatures, depending on the host crystal, and at these same temperatures the intracenter luminescence intensity was reduced most rapidly by x irradiation. It was found that among the induced activator centers there are both electron centers and hole centers. Irradiation with F-band light of previously x irradiated crystals resulted in an increase in the radiation of the activator centers in the case of KCl : Eu, and in a decrease in the case of KI : Eu. It is concluded that under these conditions in the case of KCl : Eu the process of recombination of electrons with hole activator centers is predominant and the original luminescence centers are reconstituted, whereas in the case of KI : Eu the transformation of the europium ionic centers by their interaction with electrons is the predominant process. After a brief discussion of the structure of hole activator centers, it is noted that the data are still too few to determine whether the europium hole centers have the same structure in all the investigated hosts, and it is suggested that even in the same host there may be europium hole centers with different structures. (ATD)

9443 RADIATION EQUILIBRIUM OF THE PROCESSES OF CREATION OF ELECTRON CENTERS IN NaCl–Ni PHOSPHOR. Krongauz, V. G.; Parfianovich, I. A. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 839-41(May 1967). (In Russian).

On the assumption that the luminescence of NaCl : Ni phosphors is due to recombination of electrons with Ni^{2+} centers and that the constant weakening of the roentgenoluminescence of these phosphors is due to reduction of the charge of the Ni^{2+} ions in the process of x irradiation, it is concluded by a simple kinetic argument that the ratio of the roentgenoluminescence intensity to the brightness of the F-band stimulated flash should be a linear function of the reciprocal of the F-center concentration. This relation was verified experimentally for several NaCl : Ni phosphors. The fact that the experimental line did not pass through the origin shows that the probability for the release of an electron from an F center by the action of x rays is not zero. From this it is concluded that in addition to the usually accepted hole mechanism of the ausleuchtung action of x rays, there is effective also an electron or exciton mechanism. It is suggested that an electron mechanism of the ausleuchtung action of x rays might be the ionization of F centers by "hot" electrons produced in the interaction of the x rays with matter. An NaCl : Ni phosphor was x irradiated for 16 minutes at room temperature, during which time the roentgenoluminescence intensity steadily decreased and the F-band absorption increased. The irradiation was then interrupted for 4 minutes while the crystal was heated to 400°K and cooled again to room temperature. This heating during the dark interval resulted in a considerable bleaching of the F centers and in a temporary increase in the roentgenoluminescence intensity. Nevertheless, when x irradiation was resumed, the F-band absorption continued to decrease for a short time (of the order of a second) before resuming its upward trend under the action of the x rays. This is regarded as evidence for a shifting radiation equilibrium between the F centers and Ni^+ centers. (ATD)

9444 DISLOCATION STRUCTURE AND OPTICAL PHENOMENA IN FILAMENTARY IONIC CRYSTALS. Elango, A. A. (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 845-7(May 1967). (In Russian).

Pure and activated filamentary alkali metal halide crystals were grown through collodion membranes from saturated aqueous solutions. Dislocations were studied by the selective etching method and by micro-x-ray diffraction. Crystals thinner than 15µ had no axial dislocation, or just one of them; crystals with a 30 × 25 µ cross section had up to four axial dislocations. In view of the few dislocations in filamentary crystals, it was considered of interest to investigate such electronic processes in them as might be thought to be structure-sensitive. Studies of the growth of F centers in x-irradiated filamentary NaCl and KCl crystals revealed the F-center concentration to be a linear function of the x-ray dose over a certain dose range. From this it is concluded that the Seitz mechanism, according to which the linear stage in the growth of F centers is associated with anionic vacancies produced by the interaction of electronic excitations with dislocation breaks, is incorrect. Studies of the luminescence spectra of KCl : Tl phosphors showed that the electron-hole mechanism of energy transfer to the Tl^+ centers is more effective in filamentary crystals than in large single crystals. Exciton excitation did not take place either in large or in filamentary KCl : Tl crystals. The roentgenoluminescence spectrum at liquid nitrogen temperature of a pure KCl filamentary crystal revealed the band with a maximum at 2.3 eV that is due to recombination of an electron and a self-trapped hole in the undamaged lattice. It is concluded that many physical processes associated with mobile electrons and with mobile and self-trapped holes take place in much the same way in filamentary crystals as in large crystals. (ATD)

9445 HOLE CENTERS AND HOLE PROCESSES IN ALKALI METAL HALIDE CRYSTALS. Vitol, I. K.; Bogan, Ya. R.; Zirap, V. E. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 854-8(May 1967). (In Russian).

A discussion in rather general terms of certain aspects of mobile defects (defectons) in alkali metal halides is based on a bibliography of 39 papers (over half of them western) published during the last decade. Three different kinds of hole-type defectons are distinguished: H′, H, and V_k centers, with negative, zero, and positive charge, respectively. The negatively charged H′ centers are not called hole centers, but they are regarded as hole-type defectons. Particular attention is given in the discussion to models of hole centers and possible mechanisms for the production of hole centers by ionizing radiation, and to the effect of electron and hole trapping centers on the accumulation of F centers under the action of radiation. Rather reliable models are fortunately available for the H, H′, and V_k defectons, and by studying the interaction of these defectons with V_1, V_2, V_4, V_7, F, and other centers information can be obtained concerning the structure of the latter. From the behavior of the optical absorption at temperatures above and below that at which V_1 centers decay, it is concluded that V_k and V_4 centers arise when V centers decay. From this, from the known fact that V_k and V_4 centers can be produced by the thermal destruction of H centers, and from other data, it is concluded that H defectons are very probably released from V_1 centers and from V centers of other types. From the fact that V_1, V_2, V_4, and V_7 centers are not produced at low (helium) temperatures, and from general considerations, it is concluded that H and V_k defectons can probably react with anion, cation, and dual vacancies, and that products of such reactions are the known V_1, V_4, and V_2 centers. The fine structure of the temperature dependence of the rate of production by hard radiation of F centers is interpreted in a general way in terms of the production of defectons, the production of F centers by the entrapment of electrons in vacancies, and different competing processes, including stable entrapment of electrons by electron centers and the transformation of F centers into F′ centers by electron entrapment. (ATD)

9446 COLOR CENTERS IN NEODYMIUM-CONTAINING GLASSES. Brachkovskaya, N. B.; Karapetyan, G. O.; Yudin, D. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 807-8(May 1967). (In Russian).

The EPR spectra of ultraviolet- and γ irradiated simple and commercial glasses, containing or not containing neodynium and/or cerium, were investigated as part of a program of exploring the suitability of different types of glasses for use in lasers. No appreciably paramagnetic centers were produced within the glasses by the action of 100 laser flashes, but in a thin surface layer on commercial glass rods there were produced centers that gave rise to a 500-Oe-wide EPR line with a g factor exceeding 2; these centers are ascribed to oxygen atoms. When the glass was ground to 0.19-mm-diameter grains, approximately 10-Oe-wide EPR lines with g factors close to that of the free electron were induced by irradiation with ^{60}Co γ rays or with a hydrogen lamp, but not by irradiation with a mercury lamp. The presence of neodymium in the glass had very little effect on these induced EPR spectra, but the presence of cerium considerably reduced their intensity. The effect of γ irradiation on the luminescence of commercial glasses was also investigated. The luminescence of neodymium in the investigated commercial glasses, which also contained cerium, was very little affected by the γ irradiation. The following conclusions are drawn: (1) neodymium does not participate in the processes accompanying the action of ionizing radiations on glass, and the luminescence of neodymium is almost unaffected by γ irradiation; (2) cerium hinders the formation of paramagnetic centers in a glass matrix and effectively protects the glass from radiation damage; and (3) the EPR spectra are different for the surface layer and for the radiation traps. (ATD)

9447 ELECTRON EXCITATION OF IONIC CRYSTALS AND ELEMENTARY MECHANISMS OF COLOR CENTER FORMATION. Lushchik, Ch. B.; Vale, G. K.; Elango, M. A. (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 820-8(May 1967). (In Russian).

The paper reviews the basic facts and ideas on the elementary mechanisms of radiation-induced formation of the simplest color centers in alkali metal halide crystals from the physical viewpoint. Electron and shock mechanisms, electron excitation of ionic crystals, structural defects, color formation in ionic crystals by uv radiation and high-energy particles and quanta, and mechanisms of radiation-induced formation of F centers in ionic crystals are considered. (JPRS)

9448 A POSSIBLE STUDY OF PHASE TRANSFER OF FIRST ORDER IN NON-MOESSBAUER SUBSTANCES BY MEANS OF GAMMA QUANTA RESONANCE ABSORPTION. Skorchev, B.; Gochev, D.; Kaidumov, B.; Andreeva, R. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 20: 545-7(1967).

The temperature changes of the Moessbauer spectrum of a stannic sulfide suspension in frozen sulfur were studied. Stannic sulfide possesses an abnormally strong effect at the temperature of polymorphic conversion of sulfur (95.6°C). Analogous studies were also made with a stannic sulfide suspension in salol which melts at 38°C. A change at the melting point is also observed in the courses of $\epsilon(0)$ and Γ_{ex}. (M.H.R.)

9449 MAGNETIC POINT GROUPS, SELECTION RULES, AND THE ANTIFERROMAGNETIC PHASE TRANSITION IN UO_2. Cracknell, A. P.; Daniel, M. R. (Univ. of Essex, Eng.). Proc. Phys. Soc. (London), 92: 705-12(Nov. 1967).

Previous work on crystal-field theory for UO_2 has not made use of the fact that in its ordered antiferromagnetic state its structure is properly described by one of the magnetic (Shubnikov) point groups. In the present paper the theory of the splitting of atomic energy levels in a crystalline field with the symmetry of one of the magnetic point groups is applied to UO_2. This shows that selection rules do not necessarily invalidate the theory given by Blume of the first-order antiferromagnetic phase transition in UO_2. (auth) (UK)

9450 THEORY OF ANTISYMMETRIC EXCHANGE IN RARE-EARTH SYSTEMS. White, Robert M.; White, Robert L. (Stanford Univ., Calif.). Phys. Rev. Lett., 20: 62-5(Jan. 8, 1968).

A calculation of the Coulomb exchange interaction between an electron in a Kramer's doublet and a second electron is presented, demonstrating that the resultant exchange splitting contains both anisotropic symmetric and antisymmetric contributions of comparable magnitude and of exactly the same origin. (M.H.R.)

9451 ABSORPTION OF BREMSSTRAHLUNG IN ALKALI METAL HALIDE CRYSTALS OF DIFFERENT CHEMICAL COMPOSITION. Vorob'ev, V. A.; Sokolov, G. P. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 147-9(1967). (In Russian).

This is a continuation of an earlier study of the variation of the absorbing ability of a substance as a function of the energy parameters of the incident radiation beam. The purpose of the investigation was to obtain criteria by which radiation-physical and radiation-chemical changes produced by irradiation in crystals of one composition can be used to estimate the changes produced in crystals of a different composition. To this end, the variation of absorption of bremsstrahlung in alkali metal halide crystals was investigated by calculating the thicknesses of the equivalent absorbers. The equivalent absorber in these investigations was taken to be the thickness of a layer, in which the absorbed energy is equal to the energy of bremsstrahlung absorbed in a standard layer, in which it is taken to be unity. Plots are presented of the dependence of the equivalent absorbers on the thickness of KCl, KBr, and KI at a maximum bremsstrahlung energy of 30 MeV, and of the dependence of the equivalent absorbers of KCl on the thickness of the crystal at maximum energies of 6, 10, and 30 MeV. The results show that for crystal thicknesses below 12 cm (for 30-MeV bremsstrahlung), an increase of the effective atomic number leads to a decrease in the thickness of the equivalent absorber. At large thicknesses, absorbers with a smaller atomic number have smaller equivalent-absorber thicknesses. It is concluded that when different materials are exposed to bremsstrahlung having the same maximum energy, the absorbed energy can be the same for layers of identical thickness, provided the maximum energy of the bremsstrahlung is the same. In the case of bremsstrahlung of different energies, no equivalence can be established, and different thicknesses of material must be used. (ATD)

9452 FEASIBILITY OF SPECTROMETRY OF COHERENT BREMSSTRAHLUNG WITH THE AID OF REFLECTION FROM A SINGLE CRYSTAL. Korobochko, Yu. S. (Leningrad Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 127-9(1967). (In Russian).

This is a continuation of earlier work (Zh. Eksp. Teor. Fiz., 48: 1248(1965)), dealing with the detection of coherent bremsstrahlung in the x-ray region, by using a proportional counter, i.e., under conditions of very low resolution (20 to 30%). Under the assumption that the coherent-bremsstrahlung spectrum can be investigated in the high-resolution region by reflection from a single crystal, in a manner similar to that used to investigate the characteristic-radiation spectra, it is shown that the Bragg condition can be satisfied for a large range of reflection angles, thereby increasing the transmissivity of the method without resorting to bending of the crystal. The feasibility of such a procedure is demonstrated by theoretical calculations. (ATD)

9453 FORMATION OF A PARAMAGNETIC CENTER AT THE END OF THE PROTON RANGE IN SILICON. Luetgemeier, H.; Schnitzke, K. (Siemens Aktiengesellschaft, Erlangen, Ger.). Phys. Lett., 25A: 726-7(Nov. 20, 1967). (In German).

A new isotropic center S2 is observed at the end of the range of protons in silicon. By etching the irradiated samples in steps of a few microns, the dependency of the production rate of the centers S1, S2, P1 and P3 was investigated.

9454 MOESSBAUER EXPERIMENTS WITH ^{57}Fe BETWEEN 1 AND 0.08°K. Ehnholm, G. J.; Katila, T. E.; Lounasmaa, O. V.; Reivari, P. (Technical Univ. of Helsinki). Phys. Lett., 25A: 758-9(Nov. 20, 1967).

Using a ^{3}He/^{4}He dilution refrigerator, the polarization of cobalt nuclei in iron was investigated by measuring the Moessbauer spectrum of ^{57}Fe down to 0.08°K. Good agreement between theory and experiments was obtained above 0.12°; below this temperature equilibrium difficulties prevented meaningful results. (auth)

9455 ^{125}Te MOESSBAUER EFFECT STUDY OF MAGNETIC HYPERFINE STRUCTURE IN THE FERROMAGNETIC SPINEL $CuCr_2Te_4$. Ullrich, J. F.; Vincent, D. H. (Univ. of Michigan, Ann Arbor). Phys. Lett., 25A: 731-2(Nov. 20, 1967).

The Moessbauer hyperfine spectrum of ^{125}Te has been measured in the ferromagnetic spinel $CuCr_2Te_4$. The hyperfine field was found to be 148 ± 5 kOe. The nuclear magnetic moment of the 35.6-keV excited state of ^{125}Te was determined to be + 0.74 ± 0.07 nm. (auth)

9456 ION IMPLANTATION OF SILICON. 1. ATOM LOCATION AND LATTICE DISORDER BY MEANS OF 1.0-MeV HELIUM ION SCATTERING. Davies, J. A.; Denhartog, J.; Eriksson, L.; Mayer, J. W. (Chalk River Nuclear Labs., Chalk River, Ont.). Can. J. Phys., 45: 4053-71(Dec. 1967).

The implantation behavior of Sb in silicon has been investigated by studying the orientation dependence of the backscattering yield of a 1.0-MeV helium beam. This orientation dependence (channeling) provides quantitative information on the location of implanted atoms in the lattice and also on the amount of lattice disorder accompanying the implantation. The general principles of the channeling technique and the advantages of using a beam of He^+ rather than H^+ are discussed. Results for 25 and 450°C implantations are presented and compared. The hot implant introduces very little lattice disorder, and a large fraction (up to 95%) of the Sb atoms is found on substitutional sites. In the 25°C implants, however, a heavily damaged region is formed around the track of each implanted Sb. At doses greater than $\sim 10^{14}$ ions/cm^2, these damaged regions overlap to produce an essentially amorphous layer, which then requires an annealing temperature of ~650°C to reorder the lattice and to achieve a high level of substitutional Sb. "Hot implant" studies have also been made for several other dopants—Ga, As, In, and Xe; however, unlike Sb, the substitutional level in all these cases never exceeded 60%. This unique behavior of Sb implants in silicon has also been found in a corresponding study of the electrical characteristics (Paper II). A preliminary investigation of boron-doped silicon, using the orientation dependence of 670-keV protons, indicates that substitutional boron atoms are removed from lattice sites by relatively small doses of energetic protons. This enhanced sensitivity to radiation does not occur for the Sb-doped samples. (auth) (Canada)

9457 RADIATION DAMAGE IN ZnO:Zn BY HEAVY IONS. van Wijngaarden, A.; Hastings, L. (Univ. of Windsor, Ont.). Can. J. Phys., 45: 3803-14(Dec. 1967).

ZnO : Zn phosphor samples were partially deteriorated by subjecting them to prolonged bombardment by energetic ions at energies below 110 keV. After the deterioration, the efficiency at the surface of the damaged phosphor was measured by means of low-speed heavy ions. The deterioration constant, C, is related to the efficiency, η, of the damaged phosphor, and to that η_0, of the undamaged phosphor as $C = ((\eta_0/\eta) - 1)n^{-1}$, where n is the irradiation dose. A relationship between the C value and the nuclear energy loss cross section for the damaging projectiles is derived. The relative magnitudes of the observed C values are in agreement with the measured nuclear energy loss cross sections for ^{40}Ar and ^{14}N. (auth) (Canada)

9458 RANGE IN TUNGSTEN OF ^{140}Ba FRAGMENTS FROM THE THERMAL NEUTRON-INDUCED FISSION OF ENRICHED URANIUM. Almodovar, I.; Paez-Mozo, E.; Gaeta, R. (Univ. of Puerto Rico, Mayaguez). J. Inorg. Nucl. Chem., 29: 2831-7 (Dec. 1967).

Differential range measurements in tungsten were made on ^{140}Ba and ^{91}Sr fragments produced in fission of thin samples of enriched uranium irradiated in the Puerto Rico Nuclear Center research reactor. Thin, uniform films of enriched uranium approximately 60 μg/cm^2 thick were deposited on stainless steel disks using an electrolytic technique. An electrolytic "peeling" method was used to remove thin surface films of tungsten oxide containing fission-product activities. The fragments of interest were then isolated from the peeled films in radiochemically pure condition. A value of 7.68 ± 0.15 mg/cm^2 was observed for the most probable range of ^{140}Ba. Values of 9.0 ± 0.2 and 11.3 ± 0.3 mg/cm^2 were observed, respectively, for the extrapolated range and the maximum penetration depth of the fragment. The experimental value for the range of ^{140}Ba was in good agreement with range values calculated from semi-empirical relations recently developed by Noshkin and Sugihara and Mukherji and Yaffe. (auth)

9459 NUCLEAR MAGNETIC RESONANCE IN METALS. Drain, L. E. (Atomic Energy Research Establishment, Harwell, Eng.). Metals Mater., 1: 195-229(Dec. 1967).

The subject is reviewed under the following headings: general (principle of magnetic resonance, applications of nuclear magnetic resonance); experimental methods (NMR spectroscopy, form of sample, pulse methods, spin echoes, special methods); NMR frequencies in pure metals (the Knight shift, theory of Knight shift, alkali metals, anisotropy of shift, liquid metals); relaxation and line-broadening effects (spin–lattice relaxation, line width and spin–lattice relaxation, dipolar interaction, indirect exchange interaction); quadrupole interactions (quadrupole splittings in pure metals, theory of quadrupole interaction, effect of mechanical deformation, specimen preparation problems, particle size effects); nuclear magnetic resonance in alloys (resonance intensities in disordered alloys, ordered alloys and intermetallic compounds, Knight shifts in alloys, electron density oscillations, liquid alloys); electronic structure of transition metals and alloys (orbital paramagnetism, core polarisation, relaxation in transition metals, Knight shifts in transition metal alloys, effect of localised moments, nuclear magnetic resonance and antiferromagnetism in metals, nuclear magnetic resonance in ferromagnetic metals); studies of atomic motion (measurement of diffusion rates, line width transitions, diffusion in alloys, relaxation times, measurement of macroscopic diffusion); applications to superconductivity (Knight shift in superconductors, spin–lattice relaxation, measurements of flux distribution); conclusions. 310 references. (UK)

9460 CONDUCTION-ELECTRON POLARIZATION AT INEQUIVALENT Pt SITES IN RARE EARTH–PLATINUM ALLOYS. Vijayaraghavan, R.; Malik, Satish K.; Rao, V. Udaya Shankar (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett., 20: 106-8(Jan. 15, 1968).

The conduction electron polarization in rare earth metals and alloys has been investigated by various techniques. In particular, one can test the applicability of the Ruderman–Kittel–Kasuya–Yosida theory to explain the observed polarizations, although sometimes the simpler but less realistic uniform-polarization model is used. Deductions are reported that were made from the study of the ^{195}Pt Knight shifts in the intermetallic compounds RPt_2 and RPt_5 (R = La, Ce, Pr, and Nd) in the temperature range 80 to 400°K. (W.D.M.)

9461 VARIATION OF THE MODULATION METHOD FOR MEASURING METAL HEAT CAPACITY. Kraev, O. A. (Inst. of Thermal Physics, Novosibirsk, USSR). Teplofiz. Vys. Temp., 5: 817-20(Sept.-Oct. 1967). (In Russian).

One of the variants of the modulation method for the measurement of the thermal capacity of metals is proposed. Samples in the form of thin threads were heated by alternating current and resistance variations were measured by the compensation method. The thermal capacity of tungsten from 1300 to 3000°K was measured. (tr-auth)

9462 THERMAL DESORPTION OF INERT GASES IONICALLY PUMPED INTO GLASS. Grant, W. A.; Carter, G. (Univ. of Liverpool). Phys. Chem. Glasses, 8: 35-7(Feb. 1967).

The positions in glass at which ions are captured and energies with which they are trapped were determined after energetic inert gas ions were injected into a Pyrex glass surface. When the target was heated, following ion bombardment, the gas previously trapped was totally released. The resulting desorption rate of gas was monitored either by direct observation of the pressure as the experimental system was continuously evacuated or by electrical differentiation of the pressure signal when the system was closed or static. The resulting curves of desorption rate against target temperature are referred to as desorption transients. Energetic gas ions (50 to 500 eV ions) were injected into the glass envelope of a diode. The measured transients for the release of 150-eV Ne, Ar, Kr, and Xe from Pyrex glass are shown. Each curve rose from zero at a temperature which corresponded to the temperature of the glass during bombardment, peaked at a temperature between 200 and 300°C, and fell to zero near 500°C. The shape of these curves was independent of the quantity of gas trapped (up to the maximum of about $\frac{1}{10}$ of an equivalent monolayer) but there was a slight dependence upon ion energy. Thus as ion energy increased (from 50 to 500 eV for Ar ions), the rate curves peaked at higher temperatures. Under identical experimental situations, no He ions could be trapped, and thus desorbed, from the glass. If, however, a tungsten layer was condensed upon the glass, He^+ ions could be trapped. Evidently He is released from the glass almost as soon as it enters. It is suggested that the ions are located near the glass surface and held in a variety of trapping centers possessing different activation energies for desorption. It is believed that these centers are produced by radiation damage, i.e., displacement of glass atoms from their normal positions by the ion irradiation. (BBB)

9463 STUDY OF THE THERMOLUMINESCENCE AND ELECTRON PARAMAGNETIC RESONANCE OF IRRADIATED ALUMINUM SILICATES. Ioffe, V. A.; Yanchevskaya, I. S. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 265-6(Sept. 1967). Translated from Opt. Spektrosk., 23: 494-6(Sept. 1967).

Six samples of natural feldspars were irradiated in a URS-55 x-ray apparatus at 77 and 300°K. The thermoluminescence was studied in the range 77 to 600°K. The thermoluminescence spectra of all samples investigated were identical in the entire temperature interval and depended little on the irradiation temperature and preliminary thermal treatment. Similar EPR spectra were also observed for all samples. The intensity of the EPR spectrum changed in the same way as the total intensity of the thermoluminescence. It is concluded that, in irradiated feldspars, vacancy

EPR and luminescence centers are formed near the ^{27}Al nucleus with I = $^5/_2$ coupled in pairs by an exchange interaction. (A.G.W.)

9464 PREPARATION OF A ^{57}Co–Pd MOESSBAUER SOURCE. Dobrev, D.; Ruskov, T.; Tomov, T. Compt. Rend. Acad. Bulg. Sci., 20: 537-40(1967). (In French).

A new and relatively easy method is described for preparation of the source. Electrolytic deposition was employed utilizing a ^{57}CoCl$_2$ solution and thin (10 to 20 micron) palladium strips of 6 by 20 mm dimensions. The diffusion of the cobalt into the palladium lattice was accomplished by heating the palladium strip by electric current in a hydrogen atmosphere at 1100°C, reducing the cobalt hydroxide in a hydrogen atmosphere to cobalt metal, and utilizing a controlled-temperature diffusion cell under vacuum. Amplitude spectra in the low-energy region of three sources are shown, normalized according to the 14.38-keV line. (TSS)

9465 DETERMINATION OF THE GRADIENT ELASTIC TENSOR IN SODIUM IODIDE BY MEANS OF NUCLEAR MAGNETIC RESONANCE. Astrue, R. W.; Hooper, H. O. (Wayne State Univ., Detroit). Phys. Rev., 164: 1206-14(Dec. 15, 1967).

Uniaxial stress has been applied to single crystals of NaI, producing resolved satellites, or, in some crystals, only line broadening of the ^{127}I nuclear magnetic resonance due to an electric quadrupole interaction. The position of the satellite lines has been measured as a function of applied stress, and from such measurements the components of the gradient elastic tensor, $C_{11} = (3.5 \pm 0.5) \times 10^4$ statvolts/dyne, $C_{44} = (28.0 \pm 0.5) \times 10^4$ statvolts/dyne, have been determined. The changes in intensity of the ^{23}Na and ^{127}I NMR lines have been examined in the elastic and inelastic region of strain, providing information concerning dislocations in these crystals. The existence of the intensity anomaly in the ^{127}I NMR line, which appears with H_0 parallel to [100], is explained in terms of oriented dislocations and the values of the components of the gradient elastic tensor. A value 4.5 ± 1.5 for the ratio of the Sternheimer antishielding factor for the iodine ion to that for the sodium ion has been determined. It has also been possible to estimate a value of the Sternheimer antishielding factor for the iodine ion ($\lambda \approx 58$). (auth)

9466 RADIATION DEFECT PRODUCTION AND ANNIHILATION IN KCl NEAR ROOM TEMPERATURE. Sonder, E.; Templeton, L. C. (Oak Ridge National Lab., Tenn.). Phys. Rev., 164: 1106-13(Dec. 15, 1967).

Extended γ irradiation of KCl near room temperature causes the F-center concentration to saturate between 10^{18} and 10^{19} cm^{-3}. The saturation concentration is a function of the dose rate and the temperature, and is the same whether approached by production of defects in a fresh sample or by destruction of an excess number of defects in a sample that had been preirradiated under different conditions of temperature or dose rate. The temperature dependence of the saturation level can be described by an empirical activation energy of 0.4 eV between 10 and 50°C. The approach to saturation is approximately 50 times slower than the approach to the aggregation steady state, suggesting that mobile vacancies must travel much further to annihilate than to form F-aggregate centers. Observations that the approach to saturation cannot be described by simple kinetics and that the shape of decay curves depends upon previous irradiation conditions support the suggestion that the size of the centers with which vacancies annihilate depends upon previous irradiation conditions. (auth)

9467 INELASTIC ELECTRON SCATTERING IN THIN FILMS AT OBLIQUE INCIDENCE. Geiger, J. (Technische Univ., Berlin). Phys. Status Solidi, 24: 457-60(Dec. 1, 1967).

Using the dielectric theory of inelastic scattering in thin films an equation is derived for the differential scattering probability for oblique incidence of the primary electrons. The dispersion relations for surface losses are discussed. The angular dependences of energy losses and energy gains are inverse. (auth)

9468 PRISMATIC SLIP OF BERYLLIUM MONOCRYSTALS. Regnier, P.; Dupouy, J. M. (CEN, Saclay, France). Phys. Status Solidi, 23: K109-11(Oct. 1, 1967). (In French).

The beginning of the plastic flow of monocrystalline traction samples of 99.95% Be oriented so as to cause exclusively the prismatic slip of the first species (0001 at least 30′ from the traction axis) was studied. The macroscopic elastic limit varies with temperature. If the base plane is sufficiently near to the traction axis so that the basal slip can not be produced, the initial orientation of the prismatic planes is without effect on the macroscopic elastic limit. If the orientation permits simultaneous slips on the base plane and on two prismatic planes, at the temperature of liquid nitrogen there is a very rapid rate of hardening. At room temperature there is a very sharp elastic microlimit at 2 kg/mm^2. The slip lines are straight at all temperatures on the face parallel to the base plane. (J.S.R.)

9469 ELECTRON-MICROSCOPY INVESTIGATION OF VACANCY AGGLOMERATES IN ION-IRRADIATED COPPER FOILS. II. FORMATION OF THE AGGLOMERATES. Diepers, H. (Max-Planck-Inst. fuer Metallforschung, Stuttgart). Phys. Status Solidi, 24: 623-33(Dec. 1, 1967). (In German).

A study is made of the formation mechanism for the agglomerates generated in copper foils by ion bombardment. The dependence of the depth distribution of the agglomerates on foil orientation and ion energy is measured. The dependence of the density of agglomerates on the ion dose (dose curves) is determined for different foil temperatures. The results show that the agglomerates consist of Cu interstitial atoms which penetrate the lattice by directed collision sequence as dynamic crowdions. The mechanism of agglomeration is discussed on the basis of the dose curves, depth distribution curves, and some further experiments in which the dependence of the size of the agglomerates on dose, temperature and depth position is measured. (auth)

9470 MAGNETIC DILUTION OF RARE-EARTH ALUMINUM CUBIC LAVES PHASES RAl$_2$. Buschow, K. H. J. (Philips Research Labs., Eindhoven, Netherlands); Fast, J. F.; van Diepen, A. M.; de Wijn, H. W. Phys. Status Solidi, 24: 715-20(Dec. 1, 1967).

Curie temperatures and magnetizations are measured in the cubic Laves phases $R_xM_{1-x}Al_2$ (R = Gd, Tb, Er and M = Y, La, Th). Upon dilution with Y or La a linear decrease of the Curie temperature, passing through zero for x = 0, is found. Dilution with Th results in an additional decrease of the Curie temperature. This effect is attributed to small changes of the Fermi wave-vector. The results, as compared with Knight shifts, are discussed in terms of the Ruderman-Kittel-Kasuya-Yosida theory. The exchange integral Γ is found to be of the order of −0.9 eV, and definitely negative. (auth)

9471 MOESSBAUER EFFECT IN COMPLEX MULTICOMPONENT SYSTEMS. Iosilevskii, Ya. A. (Inst. of Solid State Physics, Chernogolovka, USSR). Phys. Status Solidi, 24: 749-55(Dec. 1, 1967).

A study is made of a number of low-temperature results concerning the Debye–Waller factor and the thermal shift of the Moessbauer line in solid solutions and in ideal multicomponent crystals. These do not depend in the explicit form on the concentration of the components or on the details of the microstructure and can be expressed in terms of other quantities (such as mass of an active atom and the Debye frequency of the system) which are estimated independently. The effective Debye frequencies are discussed. (auth)

9472 TYPE OF SMALL DISLOCATION LOOPS IN NEUTRON-IRRADIATED COPPER. Bourret, A.; Dautreppe, D. (CEN, Grenoble, France). Phys. Status Solidi, 24: K173-4(Dec. 1, 1967).

The results are presented of transmission electron microscopic experiments on the nature of the black dots in neutron-irradiated copper, using the stereotechnique developed by Diepers and Diehl. (M.O.W.)

9473 GALVANOMAGNETIC PROPERTIES OF NIOBIUM SINGLE CRYSTALS. Alekseevskii, N. E.; Bertel, K.-H.; Dubrovin, A. V.; Karstens, G. E. (Inst. of Physics Problems, Moscow. Inst. of Metal Physics and of Pure Metal, Dresden). JETP Lett. (USSR) (Engl. Transl.), 6: 132-4(Sept. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 637-42(Sept. 1, 1967).

The galvanomagnetic properties of niobium single crystals with resistance ratios $\alpha = \rho_{300°K}/\rho_{4.2°K}$ from 400 to 1000 were measured. (M.O.W.)

9474 INFLUENCE OF EXCHANGE NARROWING OF EPR ON THE DYNAMIC POLARIZATION OF NUCLEI. Buishvili, L. L.; Zviadadze, M. D. JETP Lett. (USSR) (Engl. Transl.), 6: 153-4(Sept. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 665-7(Sept. 1, 1967).

It is shown that simultaneous allowance for exchange interactions and dipole–dipole interactions between the electrons improves greatly the agreement between theory and experiment. (M.O.W.)

9475 MAGNETIC SUSCEPTIBILITY OF YTTRIUM SINGLE CRYSTALS. Chechernikov, V. I.; Shafigullina, G. A.; Kolesnichenko, V. E. (Moscow State Univ.). Fiz. Metal. Metalloved., 24: 567(Sept. 1967). (In Russian).

The temperature dependence of magnetic susceptibility of a pure yttrium monocrystal was studied at 80 to 300°K. The results showed that yttrium magnetic properties are temperature-independent, but are determined by collectivized d- and s-electron paramagnetism. (R.V.J.)

9476 SOURCE-SUPPORTING FOIL EFFECT ON THE SHAPE OF POSITRON TIME ANNIHILATION SPECTRA. Bertolaccini, M.; Zappa, L. (Istituto di Fisica del Politecnico, Milan). Nuovo Cim. (10), 52B: 487-94(Dec. 11, 1967).

The fraction k of positrons annihilating in source-supporting foils (mica or polyester film) was measured as a function of the foil thickness and of the atomic number of the surrounding material in which positrons are absorbed. It was found that k attains considerable values when the positron absorber has a high atomic number; at very low Z the fraction k is smaller for mica than for the polyester film. On the basis of the obtained results a procedure is indicated for correcting the time spectra. This procedure when applied to analyze time annihilation spectra in some metals, has shown that metals are characterized by a single exponential decay, in agreement with the results of recent investigations. (auth)

9477 MOESSBAUER-EFFECT STUDIES ON ^{83}Kr IN BROMIDE AND BROMATE CRYSTALS. Pasternak, M.; Sonnino, T. (Israel Atomic Energy Commission, Yavne). Phys. Rev., 164: 384-90(Dec. 10, 1967).

Mössbauer-effect studies have been performed using ^{83}Kr sources produced by the β^- decay of ^{83}Br ($T_{½}$ = 2.4hr) in various bromine compounds. Experiments were done with LiBr, NaBr, KBr, CsBr, NH_4Br, $KBrO_3$, and Kr-β-hydroquinone sources at 90°K using solid krypton absorber at 22°K. No isomer shift was observed for any of the sources, indicating that the Kr outer configuration is not perturbed by the induced dipole interaction with its neighbors. No "KrO_3" species was detected as a result of the β^- decay of Br in $KBrO_3$. Broad and symmetric emission lines were observed for the Kr-hydroquinone, the bromides, and the bromate, increasing in broadening in that order. This broadening has been explained on the basis of the formation of a local distorted crystalline field, as a consequence of the internal-conversion process of ^{83m}Kr. From the fact that symmetric line is observed, it has been concluded that at least two modes of distortion are formed in such a way as to produce opposite signs of the electric field gradient. The Debye temperature calculated for the alkali-bromide sources was found to be 60°K in average, and for that of NH_4Br a value of 90°K was derived. The techniques of source preparation and of the krypton absorber deposition are described. (auth)

9478 SYMMETRY ELEMENTS OF THE Si BRILLOUIN ZONE OBSERVED BY MEANS OF POSITRON ANNIHILATION TECHNIQUE. Faraci, G.; Turrisi, E. (Univ., Catania, Italy). Nuovo Cim. (10), 52B: 346-54(Dec. 11, 1967).

A method is described for the study of the symmetry elements of the Si Brillouin zone observed by means of the positron annihilation technique. Measurements show both a sixfold and threefold symmetry around the [111] crystallographic axis. While the evaluated value of the variation is about (13 ± 2)% the experimental data yield a value of (6 ± 3.5)%. The experimental results are discussed. (auth)

9479 MAGNETIC PROPERTIES OF INTERMETALLIC COMPOUNDS OF Co WITH RARE EARTH METALS OR Y. PART II. Lemaire, R. (Centre d'Etudes Nucleaires, Grenoble, France). Cobalt, No. 33, 201-11(Dec. 1966). (In French).

A thermal magnetic study was made of the compounds T_2Co_{17}, T_2Co_7, TCo_3, and TCo_2 (T = rare earth metals or Y). The magnetic behavior of Co atoms in these compounds was determined. (J.S.R.)

9480 MAGNETIC PROPERTIES OF INTERMETALLIC COMPOUNDS OF Co WITH RARE EARTH METALS OR Y. [PART I.] Lemaire, R. (Centre d'Etudes Nucleaires, Grenoble, France). Cobalt, No. 32, 132-40(Sept. 1966). (In French).

Previous studies made on the phase diagrams, crystallographic studies, and magnetic studies of rare earth alloys are briefly summarized. The technique used for the preparation of the rare earth–Co alloys is outlined. The magnetic properties of TCo_5 (T = Y, Ce, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er, and Tm) were determined. The crystallographic study of the alloys made it possible to specify the number and stoichiometry of the intermetallic compounds of the Co–rare earth metal system. The thermal variations of the magnetization of the compounds were measured by the extraction method. (J.S.R.)

9481 MATHEMATICAL DESCRIPTION OF MAGNETIC RESONANCE FOR SPINS THAT MOVE. Johnson, Charles S. Jr. (Yale Univ., New Haven). Amer. J. Phys., 35: 929-33(Oct. 1967).

Equations are discussed which describe magnetic resonance phenomena in the presence of spin transfers among a number of different magnetic environments. An elementary "derivation" is given for modified Bloch equations in both the differential equation and matrix forms. The introduction of rate terms into density-matrix equations is also briefly discussed. (auth)

9482 EFFECT OF O_2 CONCENTRATION IN N-TYPE Si IRRADIATED BY ELECTRONS AT 4.5 MeV. Daspet, Danielle; Bielle, Jean; de Lafond, Yann Gervais (Centre d'Etude Spatiale des Rayonnements, Toulouse). Compt. Rend., Ser. A and B, 265: 693-6(Sept. 18, 1967). (In French).

The results obtained on Si irradiated at 18°C by 4.5-MeV electrons show that the levels introduced in the upper part of the forbidden band and affecting the transport properties are controlled by the O_2 concentration. The presence of O_2 decreases the degradation degree of the transport properties and effects the nature of the complex faults created. (tr-auth)

9483 ELECTRONIC PROPERTIES OF WELL-ORIENTED GRAPHITE. Spain, I. L.; Ubbelohde, A. R.; Young, D. A. (Imperial Coll. of Science and Tech., London). Phil. Trans. Roy. Soc. London, Ser. A, 262: 345-86(Oct. 6, 1967).

A range of dense well oriented graphites of high chemical purity was prepared by stress recrystallization of pyrolytic material. Systematic trends in the galvanomagnetic and thermoelectric properties were investigated in relation to c-axis distribution function, crystallite size, and basal plane dislocation concentration, using temperatures from 300 to 1.2°K and magnetic fields up to 6700 G. Basal plane properties of ideal graphite are evaluated in terms of the trends observed. Electronic properties were measured parallel to the c axis for corresponding graphites with a range of defect concentrations. From the trends established estimates are made of various properties of ideal defect-free graphite in the c-axis direction, and of anisotropy ratios. Effects of neutron irradiation on some of the electronic properties are also described. Results are discussed in terms of multi-carrier models. (auth) (UK)

9484 ION-IMPLANTATION DOPING OF SEMICONDUCTORS. Large, L. N. (Services Electronics Research Lab., Baldock, Eng.); Bicknell, R. W. J. Mater. Sci., 2: 589-609 (Nov. 1967).

Ion-implantation has become important as a means of changing the electrical and chemical properties of bombarded materials. Of particular interest is the doping of semiconductors in order to produce changes in the conductivity of the material in a highly controlled manner. The technique may well become an important addition to the present-day industrial technology of production of solid-state circuits and devices. (auth) (UK)

9485 DISTRIBUTION OF IRON CATIONS IN A VOLCANIC PIGEONITE BY MOESSBAUER SPECTROSCOPY. Bancroft, G. Michael (Cambridge Univ., Eng.); Burns, Roger G. Earth Planet. Sci. Lett., 3: 125-7(Nov. 1967).

The Moessbauer spectrum of a pigeonite from andesite on Hakone Volcano in Japan was found to contain two quadrupole doublets consisting of an outer and inner pair of peaks. The inner peaks were assigned to Fe^{2+} ions in the M_2 positions and the outer peaks to Fe^{2+} ions in the M_1 positions. From the ratios of the computer-calculated peak areas, it was estimated that 63% of the Fe^{2+} ions are in the M_2 positions. The results were compared with those for a metamorphic orthopyroxene from charnockite in Ceylon. It is concluded that ordering in volcanic pigeonites is smaller than that in metamorphic orthopyroxenes that crystallized more slowly at lower temperatures and higher pressures. (A.G.W.)

9486 ATOMIC EXCITATION AS A RESULT OF PRIOR β DECAY OF ^{85}Kr IN SOLIDS. Micklitz, H.; Luchner, K. (Technische Hochschule, Munich). Z. Naturforsch., 22a: 1650-2(Oct. 1967). (In German).

Krypton gas enriched with ^{85}Kr was streamed over a surface cooled below its freezing point and the photons occurring in delayed coincidence with β particles in the vicinity of the emission lines at 3669, 3797, and 4136 Å were recorded. The spectral distribution of the photon emission probability in the vicinity of these lines and the half-life of the levels excited by β decay are shown graphically. (J.S.R.)

9487 ANALYSIS OF CRITICAL POINTS OF GRAPHITE FROM TEMPERATURE-MODULATED REFLECTANCE. Balzarotti, A. (Univ., Aquila, Italy. Gruppo Nazionale di Struttura della Materia del Consiglio Nazionale delle Ricerche, Rome); Grandolfo, M. Phys. Rev. Lett., 20: 9-11(Jan. 1, 1968).

The differential reflectance of graphite crystals was measured in the energy range 4 to 6.5 eV by modulating the optical constants of the crystals with temperature. The results indicate that the strong peak around 5 eV, previously observed in absolute reflectivity measurements, is due to an M_1 saddle-point singularity. A structure at 5.96 eV related to an M_0 transition occurring at the center of the Brillouin zone is also resolved by this technique. The corresponding changes of the real and imaginary parts of the dielectric constant $\Delta\epsilon_1$ and $\Delta\epsilon_2$ are derived from the data by application of the Kramers–Kronig dispersion relation. The results suggest that the effect of temperature is to shift one of the observed critical points (M_0) and to broaden the other (M_1) because of the electron–phonon interaction. (A.G.W.)

9488 ISOTOPE EFFECT FOR DIFFUSION OF ZINC AND CADMIUM IN SINGLE CRYSTALS OF ZINC. Batra, Anand Parkash. Troy, N. Y., Rensselaer Polytechnic Inst., 1966. 96p.

Thesis.

The sectioning technique and the half-life method of isotope discrimination were used to study the relative rates of diffusion of ^{65}Zn and ^{69m}Zn, and of ^{109}Cd and ^{115}Cd in high-purity zinc single crystals. The isotope effect, $E = (1-D^\beta/D^\alpha)/(1-(m^\alpha/m^\beta)^{½})$, was measured; D^α/D^β and m^α/m^β are the ratios of the diffusion coefficients and of the masses of the two isotopes, α and β, respectively. The average values for E in the self-diffusion of zinc for directions parallel and perpendicular to the hexagonal axis are 0.6682 ± 0.0243 and 0.6868 ± 0.0219, respectively. The observed isotope effect, both for parallel and perpendicular diffusions, turns out to be about 14% less than the correlation factor for self-diffusion which is the value predicted on the basis of the inverse square root mass dependence of the atomic jump frequency. This deviation is apparently due to many-body aspects of diffusion, and on these considerations it is concluded that a small fraction (about 14%) of the translational kinetic energy of the activated state is possessed by atoms other than the jumping atom. The values of E for diffusion of cadmium isotopes in zinc, parallel and perpendicular to the hexagonal axis are 0.5070 ± 0.0339 and 0.3172 ± 0.0319, respectively, at 410.1°C. These values indicate an attractive interaction between the cadmium impurity and the vacancy, the interaction being larger when both of them are in the same basal plane. Under the assumption that the many-body consideration is essentially the same as for self-diffusion and by making some reasonable simplifying approximations as to how the presence of the impurity influences the vacancy jump, the enhancement of cadmium-diffusion over zinc-diffusion is examined. It is found that the rapid interchange of the cadmium impurity with the vacancy and the greater density of the vacancies next to the cadmium impurity are both responsible for the enhancement in the diffusivity of cadmium in zinc. (auth)

Theoretical Physics

Refer also to abstracts 9075, 9261, 9265, and 9405.

9489 NUMERICAL SOLUTION OF THE NONLINEAR MAGNETOSTATIC-FIELD EQUATION IN TWO DIMENSIONS. Concus, Paul (Univ. of California, Berkeley). Contract W-7405-eng-48. J. Comput. Phys., 1: 330-42(Feb. 1967). (UCRL-16287(Rev.)).

The numerical solution of the second-order, elliptic, quasilinear, partial differential equation arising in a 2-dimensional magnetostatic-field problem, where the magnetic permeability varies with the field, is considered. The types of problems considered are those arising, for example, in the design of particle accelerators where the desired magnetic field strength is so large as to be principally in the domain of nonlinear behavior of the magnetic material. For such a problem, the usual successive-approximation methods based on the technique of linearizing about small magnetic fields may be inadequate, and a technique involving the more essential nonlinear features should be used. A set of nonlinear difference equations approximating the original differential equation was derived, and, in solving a test problem, the method of nonlinear successive overrelaxation compared favorably both to Newton's method and to a commonly used method based on a small-magnetic-field approximation. The first method, as presented here, may also be used to numerically solve similar equations, such as those for Plateau's problem or for irrotational compressible fluid flow. (BBB)

9490 RADIATION OF THE ARBITRARILY MOVING CHARGES IN THE PRESENCE OF TWO MEDIA. Magomedov, M. R. (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 170-8(1967). (In Russian).

By the method of Green's function it is obtained the solution of Maxwell's equation in the case of two dispersing media for the arbitrarily distributed external sources. The asymptotic expressions for the fields, and the polarization properties of the radiation are considered. (auth)

9491 CLASSICAL SYMMETRY GROUP OF A PARTICLE IN A SPHERICAL POTENTIAL. Guest, P. B.; Bors, A. (Univ. of St. Andrews, Fife, Scotland). Proc. Phys. Soc. (London), 92: 525-8(Nov. 1967).

From the solution of Liouville's equation for a particle in a spherical potential the vector invariants, other than the angular momentum, are found. For purely repulsive potentials the symmetry group of the system is found to be the Lorentz group, and the canonical transformations generated by the two vector invariants give functional representations of the Lorentz group. (auth) (UK)

9492 THE EXACT SOLUTION OF N TWO-LEVEL SYSTEMS INTERACTING WITH A SINGLE-MODE, QUANTIZED RADIATION FIELD. Tavis, M.; Cummings, F. W. (Univ. of California, Riverside). Phys. Lett., 25A: 714-15(Nov. 20, 1967).

The exact solution of N two-level systems interacting with a single mode, quantized radiation field are given, and some numerical examples are included. (auth)

9493 EXACT STATISTICAL MECHANICS OF A RELATIVISTIC MAGNETIC ANOMALY. Frankel, N. E.; Opat, G. I.; Spitzer, J. J. (Univ. of Melbourne). Phys. Lett., 25A: 716-17 (Nov. 20, 1967).

The anomalous magnetic behavior of a classical, relativistic, ideal, chargeless, spin-$\frac{1}{2}$ magnetic moment in a uniform external magnetic field is presented. (auth)

9494 DIFFUSION, SCATTERING, AND ACCELERATION OF PARTICLES BY STOCHASTIC ELECTROMAGNETIC FIELDS. Hall, D. E.; Sturrock, P. A. (Stanford Univ., Calif.). Phys. Fluids, 10: 2620-8(Dec. 1967).

The behavior of charged particles in an electromagnetic field composed of two parts is treated. The first is an unperturbed part, for which the solution of the Vlasov equation is assumed to be known; the second part is a perturbation which is assumed to be random and of small amplitude. Such a "stochastic" or "turbulent" electromagnetic field leads to diffusion, pitch-angle scattering, and acceleration. Equations governing these processes may be derived by test-particle calculations. The problem is first posed in a general way, and solved by a method similar to that used in quasi-linear theory. The connection of this method with the Fokker–Planck formulation is discussed. The case which is analyzed in detail is that of relativistic particles moving in a uniform magnetic field under the influence of a steady homogeneous spectrum of electromagnetic fluctuations. Results are given which are valid for any (weak) fluctuation spectrum and for finite test-particle gyroradii. The physical meaning of the results is discussed, and it is shown that in certain limits there is agreement with earlier, less general analyses. (auth)

9495 DERIVATION OF THE EQUATIONS OF MOTION OF A CLASSICAL RADIATING CHARGE. Cohn, Jack (Univ. of Oklahoma, Norman). Amer. J. Phys., 35: 949-50(Oct. 1967).

The present paper is concerned with a derivation of the equations of motion of a classical radiating charge. Although heuristic assumptions are involved in the treatment, there is compensation from the fact that the derivation involves much less mathematical complexity than is found in the customary treatments of the problem. The formulation is manifestly covariant throughout. (auth)

9496 QUANTUM-MECHANICAL TIME OPERATOR. Razavy, M. (Univ. of Alberta, Edmonton, Can.). Amer. J. Phys., 35: 955-60(Oct. 1967).

A first integral of motion in classical dynamics which contains the time explicitly and is conjugate to the Hamiltonian is quantized. The resulting quantal operator is applied to study the time delay caused by scattering, and in a simple case the expectation value of this operator is obtained. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

9497 (UCRL–17544) PHYSICS SEMIANNUAL REPORT, NOVEMBER 1966–APRIL 1967. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1967. Contract W-7405-eng-48. 113p. Dep. CFSTI.

The research covered includes high-energy physics both experimental and theoretical, bubble chamber operation and development, computer programs, data processing and health physics. The operation and development of accelerators is also covered. (J.F.P.)

Electromagnetic

Refer also to abstract 8353.

9498 PHOTOPRODUCTION OF HYPERCHARGE-ZERO RESONANT STATES FROM HYDROGEN. Mori, Shigeki. Ithaca, N. Y., Cornell Univ., 1966. 119p.

Thesis.

Differential cross sections for the processes $\gamma + p \rightarrow K^+ + Y_1^{*\circ}(1385)$ and $\gamma + p \rightarrow K^+ + Y_0^*(1405)$ were obtained at photon energies of 1.445 and 1.485 BeV, respectively, by analyzing excitation curves of K^+ meson yields in the energy range from 0.90 BeV to 1.75 BeV. An upper limit was also obtained for the process $\gamma + p \rightarrow K^+ + Y_0^*(1520)$ at an energy of 1.730 BeV. The K^+ mesons were identified by a momentum and velocity analysis system consisting of a strong focusing magnet, a series of counters (scintillation and Čerenkov) and a time-of-flight system. An additional selection of K^+ mesons was made by detecting the decay products. The magnet was set at a laboratory angle of 15 degrees. Two momentum channels were used which corresponded to about 80 and 100 degrees in the center of mass system for the $Y_1^*(1385)$ and $Y_0^*(1405)$, and to about 100 and 120 degrees for the $Y_0^*(1520)$, with an angular spread of about 30° in the center of mass system. (The corresponding photon energies for each process were the same in both momentum channels.) Differential cross sections were determined by performing a least-squares analysis on the data assuming that resonances have a Breit–Wigner mass distribution. The known mass widths were included as part of the input data. The average differential cross sections over the two momentum channels were (0.23 ± 0.12) and $(0.44 \pm 0.13) \times 10^{-31}$ cm^2/ster for the $Y_1^*(1385)$ and $Y_0^*(1405)$, respectively. The K^+ meson yields for the production of the Y_0^* (1520) were consistent with zero. Differential cross sections for the processes $\gamma + p \rightarrow K^+ + \Lambda^0$ and $\gamma + p \rightarrow K^+ + \Sigma^0$ were also obtained at photon energies of about 0.950 and 1.080 BeV, respectively. They were quite consistent with previous measurements. In addition, the K meson pair production process was studied by measuring K^- mesons at a bremsstrahlung peak energy of 1.660 BeV. Only an upper limit for the K^- mesons yield was obtained because of an extremely low counting rate and inadequate background information. The K^- mesons were detected by almost the same method as in the case of the K^+ mesons. (Disser. Abstr.)

9499 STUDY OF ELECTRON–POSITRON ANNIHILATION INTO $\pi^+\pi^-$ AT 775 MeV WITH THE ORSAY STORAGE RING. Augustin, J. E.; Bizot, J. C.; Buon, J.; Haissinski, J.; Lalanne, D.; Marin, P. C.; Perez-y-Jorba, J.; Rumpf, R.; Silva, E.; Taverniew, S. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). Phys. Rev. Lett., 20: 126-9(Jan. 15, 1968).

A preliminary measurement of the cross section for the reaction $e^+ + e^- \rightarrow \pi^+ + \pi^-$ at an energy of 775 MeV is presented. Electron–positron pairs from large-angle Bhabha scattering and $\pi^+ + \pi^-$ pairs were detected in same experimental setup, which was comprised of two identical arrays of scintillation counters and spark chambers. Thus the $\pi^+ + \pi^-$ events could be monitored by the e^+e^- scattering, assuming quantum electrodynamics, and an absolute value of the cross section deduced. This value was found to be $1.53 \pm 0.25\ (10)^{-30}$ cm^2. The branching ratio for $\rho^0 \rightarrow e^+ + e^-$ decay was also estimated. (J.F.P.)

9500 ELECTROPRODUCTION OF PIONS. Blechschmidt, H. (DESY, Hamburg); Dowd, J. P.; Elsner, B.; Heinloth, K.; Karow, P.; Rathje, J.; Schmidt, D.; Smith, J. H.; Kanaris, A.; Wynroe, Å. G. Nuovo Cim. (10), 52A: 1370-4(Dec. 21, 1967).

The electroproduction of single pions on hydrogen was measured in a spark-chamber experiment at energies of the virtual photon from 0.7 to 3 GeV, detecting the scattered electron and the produced pion in coincidence: $e + p \rightarrow e' + \pi^+ + n$. Positive or negative pions from multiple-pion production $e + p \rightarrow e' + \pi^\pm + (N + \pi + \ldots)$ were also detected. Cross sections were measured and compared with experimental results from photoproduction of positive pions. (L.B.S.)

9501 PHOTOPRODUCTION OF ρ^0 MESONS ON HYDROGEN, CARBON, AND ALUMINUM WITH PHOTONS OF KNOWN ENERGY. Blechschmidt, H.; Dowd, J. P.; Elsner, B.; Heinloth, K.; Hoehne, K. H.; Raither, S.; Rathje, J.; Schmidt, D.; Smith, J. H.; Weber, J. H. (DESY, Hamburg). Nuovo Cim. (10), 52A: 1348-52 (Dec. 21, 1967).

A spark-chamber experiment was performed to study the photoproduction of ρ^0 on hydrogen, carbon, and aluminum at 3.2 to 4.9 GeV in the $\gamma + A \rightarrow A + \pi^+ + \pi^-$ interaction. Values for the ρ mass and width obtained from the invariant-mass spectrum of the two-pion system were found in good agreement with experiment. Differential and total cross sections were also measured. (L.B.S.)

9502 PHOTOPRODUCTION OF K^+ MESONS AT 3.4 AND 5.0 GeV. Joseph, P. M.; Hicks, H.; Litt, L.; Pipkin, F.; Russell, J. J. (Harvard Univ., Cambridge, Mass.). Phys. Lett., 26B: 41-4(Dec. 11, 1967).

Measurements of the photoproduction from hydrogen of single K^+ mesons at gamma ray energies of 3.4 and 5.0 GeV and at laboratory angles of 5.1°, 7.1°, 9.9°, and 15.1° are reported. The s dependence at fixed t is derived for momentum transfers of -0.25 and -0.37 (GeV)^2. (auth)

9503 DIRECT PAIR PRODUCTION BY MUONS IN MEDIUM AND LOW Z ELEMENTS. Das, A. K.; Sinha, M. S. (Regional Engineering Coll., Durgapur, India). Proc. Phys. Soc. (London), 92: 110-16(Sept. 1967).

The direct production of electron pairs by cosmic-ray muons (mean energy 6 GeV and minimum energy 0.85 GeV) in carbon, aluminum and copper targets of thicknesses 0.06, 0.14 and 0.44 radiation units, respectively, was studied with two multi-plate cloud chambers. Showers of two or more electrons associated with each outgoing muon from the targets were selected, and the energy transfer in each event was estimated. The results, after necessary corrections, show that the experimental cross sections for direct pair production events in the region of energy transfers 12 to 1000 MeV are in approximate agreement with the theory of Murota–Ueda–Tanaka. They also support the expected $Z(Z + 1)$ variations of the cross sections and the required variation with the mean primary muon energy. The data also indicate that the most appropriate value of the arbitrary parameter α in the Murota–Ueda–Tanaka theory is 2. (auth)

Weak

9504 A DETERMINATION OF THE β PARAMETER AS A TEST OF T-INVARIANCE IN THE CHARGED DECAY MODE OF THE Λ HYPERON. Cleland, W. E. (CERN, Geneva); Bienlein, J. K.; Conforto, G.; (and others). Phys. Lett., 26B: 45-8(Dec. 11, 1967).

The β parameter of $\Lambda \rightarrow p + \pi^-$ was measured. It was found that $\beta = -0.13 \pm 0.07$, in agreement with time reversal invariance. The Λ polarization in $\pi^- + p \rightarrow \Lambda + K^0$ at 1.03 GeV/c and 1.06 GeV/c is also given. (auth)

9505 MEASUREMENT OF MOMENTUM OF MUONS FROM PION DECAY UPPER LIMIT FOR MUON NEUTRINO MASS. Booth, P. S. L.; Johnson, R. G.; Williams, E. G. H.; Wormald, J. R. (Univ. of Liverpool). Phys. Lett., 26B: 39-40(Dec. 11, 1967).

The momentum of muons, emitted in a positive pion decay at rest, was measured using a magnetic spectrometer to be 29.800 ± 0.018 MeV/c. It is deduced that an upper limit for the mass of the muon neutrino is 1.2 MeV/c^2, at the 68% confidence level. (auth)

9506 TYPE OF COUPLING AND STRUCTURE OF THE FORM FACTOR IN THE K_{e3}^+ DECAY. Bellotti, E.; Fiorini, E.; Pullia, A. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cim. (10), 52A: 1287-1305(Dec. 21, 1967).

The decay $K^+ \rightarrow e^+ + \pi^0 + \nu$ was studied with a heavy-liquid bubble chamber in order to identify the positron track and to detect and measure the electron-positron pairs from the materialization of the γ-rays. For comparison with our experimental data the various theoretical spectra were modified by means of a Monte Carlo method for the variation of the detection efficiency and for measurement resolution. From this comparison, where radiation corrections were taken into account, a strong neutrino-positron asymmetry can be excluded, which would have indicated a violation of lepton locality or a dominance of the mixed scalar-tensor term. The angular distribution of the neutrino momentum with respect to the pion momentum is completely consistent (28% χ^2 probability) with a pure vector coupling. Pure scalar and tensor couplings are excluded with χ^2 of 110.83 and ~2500 respectively for 9 degrees of freedom. Possible contribution to the decay from scalar and tensor terms are both less than 9%. Under the hypothesis of a pure vector coupling the structure of the form factor indicates a value of (700$^{+}_{-}$[illegible]) MeV for the mass of the exchanged meson. From this value and from the decay rate obtained in this experiment $[(4.19 \pm 0.42) \cdot 10^6\ s^{-1}]$, the value (12.82$^{+}_{-}$[illegible]) degrees is obtained for the Cabibbo angle. (auth)

9507 THE HALF-LIFE OF THE FREE NEUTRON. Christensen, C. J.; Nielsen, A.; Bahnsen, A.; Brown, W. K.; Rustad, B. M. (Danish Atomic Energy Commission, Riso). Phys. Lett., 26B: 11-13(Dec. 11, 1967).

A measurement of the half-life of the free neutron yields $T_{1/2}$ = 10.80 ± 0.16 min. (auth)

9508 SEARCH FOR THE DIRECT DECAY $K^+ \rightarrow \pi^+ + \gamma + \gamma$. Chen, M. (Univ. of California, Berkeley); Cutts, D.; Kijewski, P.; Stiening, R.; Wiegand, C.; Deutsch, M. Contract W-7405-eng-48. Phys. Rev. Lett., 20: 73-5(Jan. 8, 1968). (UCRL-17906).

The measurement of the branching ratio for the direct decay $K^+ \rightarrow \pi^+ + \gamma + \gamma$, where the invariant mass of the two gamma rays is not equal to the π^0 mass, has considerable theoretical importance. An upper limit of 1.1×10^{-4} for this branching ratio was experimentally established. The results were used to set a limit on the off-the-mass-shell variation of the $K^+ \rightarrow \pi^+ + \pi^0$ amplitude. (auth)

Strong (Baryon-Induced)

Refer to abstract 9509.

Strong (Meson-Induced)

Refer also to abstract 9504.

9509 (INR-P-826/VI/PH) SUPER-HIGH-ENERGY INTERACTIONS IN LARGE BLOCKS OF PHOTOGRAPHIC EMULSION. Czachowska, Z.; Gierula, J.; Krzywdzinski, S.; Miesowicz, M.; Rybicki, K.; Wolter, W. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 17p. Dep.

A review of some results on super-high energy interactions obtained from the ICEF and Brawley emulsion stacks is presented. The determination of the proton−nucleon elastic cross section in the TeV region, detailed experimental analysis of nucleon−nucleon collisions between 10^{12} and 10^{14} eV, coherent production of particles in collisions of 200-GeV mesons (π) with emulsion nuclei, and meson (π) interactions at 200 GeV are covered. The results given in general confirm multiple production by the emission of fireballs with the preservation of individuality of the incident particle. Also some information is obtained on other processes such as elastic scattering and meson (π) interactions including coherent production. (J.F.P.)

9510 THE SCATTERING OF POSITIVE PIONS BY PROTONS AT 97.1 MeV. Edwards, D. N.; Frank, S. G. F.; Holt, J. R.; Massam, T.; Myatt, G. (Univ. of Liverpool). Proc. Phys. Soc. (London), 92: 602-8(Nov. 1967).

The differential cross section for the scattering of 97.1 MeV positive pions by protons was measured at fourteen angles between 36.3 and 164.1° in the center-of-mass system. After subtraction of first-order Coulomb effects the cross section is given (in mbn sterad^{-1}) by $d\sigma/d\Omega = (2.873 \pm 0.039) - (2.872 \pm 0.057) \cos\theta + (5.08 \pm 0.11) \cos^2\theta$. The total cross section was measured, by attenuation, as 56.1 ± 1.7 mbn. The values of the phase shifts uncorrected for D-wave or higher-order Coulomb effects were found to be $\alpha_{33} = 20.95 \pm 0.32°$, $\alpha_{31} = -2.24 \pm 0.18°$, and $\alpha_3 = -8.59 \pm 0.23°$. The magnitudes of the corrections are discussed. These phase shifts were used, together with previous measurements of negative pion elastic scattering, to derive the following values for the T = ½ phase shifts at the same energy; $\alpha_1 = 7.93 \pm 0.42°$, $\alpha_{11} = -1.90 \pm 0.30°$, and $\alpha_{13} = -0.60 \pm 0.30$. (auth)

9511 THE CHARGE-EXCHANGE SCATTERING OF NEGATIVE PIONS BY PROTONS AT 96.6 MeV. Frank, S. G. F.; Holt, J. R.; Massam, T.; Myatt, G. (Univ. of Liverpool). Proc. Phys. Soc. (London), 92: 609-17(Nov. 1967).

The angular distribution of γ rays from the charge-exchange scattering of 96.6 MeV negative pions by protons was measured at 14 angles between 20 and 151.2°. The γ-ray detector utilized a lead converter and counter telescope. The correction for loss of electrons in the converter was determined experimentally, and the calculated efficiency of the detector checked by direct measurement with a tagged beam of γ rays. Analysis of the distribution of γ rays yielded the following differential cross section for the charge-exchange scattering (mbn sterad^{-1} cm): $d\sigma/d\Omega = (0.694 \pm 0.047) - (1.56 \pm 0.05) \cos\theta + (1.89 \pm 0.14) \cos^2\theta$. Using previously determined values for the T = 3/2 phase shifts, those for the T = ½ state were found to be $\alpha_1 = 8.28 \pm 0.56°$; $\alpha_{11} = 5.0 \pm 1.1°$; and $\alpha_{13} = -0.23 \pm 0.47°$. (auth)

9512 DI-PION PRODUCTION IN HIGH-ENERGY π^-p COLLISIONS. Walker, W. D.; Thompson, M. A.; Robertson, W. J.; Oh, B. Y.; Lee, Y. Y.; Hartung, R. W.; Garfinkel, A. F.; Erwin, A. R.; Davis, J. L. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev. Lett., 20: 133-6(Jan. 15, 1968). (COO-881-122).

The observation of the two processes $\pi^- + p \rightarrow \pi^- + \pi^0 + p$ and $\pi^- + p \rightarrow \pi^- + \pi^+ + n$ at bombarding energies of 7.0 and 25 BeV is reported. A process in which the nucleon is dissociated seems to be present at 7.0 BeV and is dominant at 25 BeV. Arguments are presented to show that the results are consistent with diffraction dissociation. (auth)

9513 SIMPLE SYSTEMATIC BEHAVIOR IN MULTIPLE PION PRODUCTION IN 25-GeV/c π^-p COLLISIONS. Elbert, J. W.; Erwin, A. R.; Mikamo, S.; Reeder, D.; Chen, Y. Y.; Walker, W. D.; Weinberg, A. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev. Lett., 20: 124-6(Jan. 15, 1968). (COO-881-147).

An experiment is discussed in which there is a significant correlation between the multiplicity of events and the distribution of both longitudinal and transverse momentum. The events were produced by 25-GeV/c mesons (π^-) in a hydrogen bubble chamber. The analysis is limited to events with 6 to 16 visible outgoing prongs. (J.F.P.)

9514 INELASTIC π^-p INTERACTIONS WITH SMALL MOMENTUM TRANSFER. Azimov, S. A.; Muminov, M. M.; Prozorova, E. P.; Rizaev, Kh. A.; Yuldashev, A. A. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 7, 20-2(1967). (In Russian).

The inelastic π^-p interactions of the $\pi^- + p \rightarrow \pi^- + p$ + neutral particles with small momentum proton emission were studied in a propane bubble chamber. The observed 4000 stereopictures also recorded the electron−positron pairs which usually were selected as belonging to the studied event. The results of measurements indicated 37 γ quanta which produced electron−positron pairs collinear with the initial star. Evaluations were made of the neutral particles emitted in reaction $\pi^- + p \rightarrow \pi^- + p + x_0$ at 7 GeV/c. The analysis of π^0 mesons showed a mean number of mesons (π^0) equal to 1.5 ± 0.3 and confirmed that the meson (π^0) is the only source of generation of γ quanta. (auth)

9515 A STUDY OF THE BACKWARD PEAK IN THE ΛK^0 ASSOCIATED PRODUCTION AT 5, 7, AND 12 GeV/c. Pepin, M.; (Eidgenoessiche Technische Hochschule, Zurich); Beusch, W.; Fischer, W. E.; Polgar, E. E.; Bowen, R.; Brautti, G.; Michelini, A.; Astbury, P.; Websdale, D. Phys. Lett., 26B: 35-8(Dec. 11, 1967).

Data are presented on the total and differential cross sections for the backward peak in the ΛK^0 associated production. The polarization of the Λ is found to be consistent with 100%. (auth)

9516 EVIDENCE FOR A K*(1660) RESONANCE IN K^+p REACTIONS AT 5 GeV/c. Jobes, M. (Univ. of Birmingham, Eng.); Matt, W.; Bassompierre, G.; (and others). Phys. Lett., 26B: 49-52(Dec. 11, 1967).

K^+p interactions at an incident momentum of 4.97 GeV/c show evidence for a new $K\pi\pi$ resonant state K*(1660), at a mass of (1660 ± 10) MeV, full width (60 ± 20) MeV. Decays into K*(1420)π and K*(892)π are found. In addition there is an indication of a $K\pi$ decay mode. (auth)

9517 EVIDENCE FOR THREE $K\pi\pi$ RESONANT STATES BELOW 1.4 GeV in K^+p REACTIONS AT 5 GeV/c. Bassompierre, G. (CERN, Geneva); Goldschmidt-Clermont, Y.; Grant, A.; (and others). Phys. Lett., 26B: 30-4(Dec. 11, 1967).

The study of K^+p reactions at an incident momentum of 4.97 GeV/c suggests that the wide enhancement in the $(K\pi\pi)^+$ mass spectrum may be split into several resonant states. In particular, examination of the K*(892)π decay mode indicates the existence of the states K*(1230), K*(1280), and K*(1320), in addition to the well known K*(1420). The K*(1230) and K*(1320) have the properties expected from 1^+ states produced by 0^+ exchange. (auth)

9518 PION-NUCLEON CHARGE-EXCHANGE SCATTERING AND HIGH-ENERGY DYNAMICS. I. THE DIFFERENTIAL CROSS SECTION. Van Hove, Leon (CERN, Geneva). Comments Nucl. Particle Phys., 1: 191-5(Nov.-Dec. 1967).

The important conclusions drawn from an extensive experimental program at CERN on the $\pi^- + p \rightarrow \pi^0 + n$ interaction at 4.0 to 18.2 GeV/c are reviewed. The dependence of the differential cross section $d\sigma/dt$ at fixed t on the pion lab momentum is compared with predictions of the Regge-pole model. (L.B.S.)

9519 THREE AND FIVE PION FINAL STATE COHERENTLY PRODUCED ON NUCLEI BY 16 GeV/C NEGATIVE PIONS. Lubatti, Henry Joseph. Contract Nonr-3656(13) NR 021 007. Berkeley, Calif., Univ. of California, 1966. 67p. Thesis.

Production of three- and five-charged pions from nuclei is studied. It is shown that the three-pion final states result from coherent interactions on nuclei which yield mainly $\rho^0\pi^-$ states (66% of the time). If a single resonance dominates the $\rho^0\pi^-$ channel it occurs at 1020 MeV with $\Gamma = 250$ MeV. Assuming that the A_1 is observed in this experiment one obtains the ratio ($A_1 \rightarrow$ five charged pions/$A_1 \rightarrow \rho\pi$) < 0.6% with 90% confidence. Events with f^0 account for approximately 10% of the events. The $f^0\pi^-$ mass spectrum peaks at 1600 MeV. There is no evidence that the five pions are produced in coherent interactions. There is a broad peak in the five-pion mass spectrum near 2000 MeV which is associated with small momentum transfer. The $\pi^-\pi^-\pi^+$ and $\pi^-\pi^+$ mass spectra from the five-pion events show structure at the A_1 and ρ, respectively. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 9635, 9686, and 9712.

9520 NEW DETERMINATION OF κl IN NONLINEAR SPINORIAL THEORY. Geheniau, J.; Schomblond, Ch.; Michel, F. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 53: 423-31(1967). (In French).

The first two terms of a formal Neumann series (instead of the first term only) were used as an approximate solution of the integral equation for three-point functions. Certain contributions of these functions are considered for the determination of κl. It is found that $\kappa l = 4.71$. The former value is 6.39. The one which gives experimental agreement with the masses of mesons (π) and (η) lies between these two numbers. (tr-auth)

9521 GREEN FUNCTIONS IN THE THEORY OF QUANTUM KINETIC EQUATIONS. I. Smolyanskii, S. A. (Saratov State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 117-21 (1967). (In Russian).

Dynamic equations with an infinite degree of freedom are found in a strongly confluent state. A causality principle formulated produced a particular solution for dynamic equation and for kinetic equation simultaneously. The developed causality principle is applicable also for many-time formalism of correlation functions and gives the basis for the Green's time-dependent temperature functions in the kinetic equation theory. (tr-auth)

9522 ALGEBRA OF CURRENTS. Efremov, A. V. pp 383-93 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The reason for the recent flood of studies dealing with current algebra is that this type of algebra pertains to a new type of symmetry which is not associated with interchangeability of a given group of particles with respect to some type of interaction. The implications of current algebra are of interest, since this algebra makes it possible to interrelate all three fundamental types of elementary particle interactions: weak, electromagnetic and strong. In this connection, the nature of current algebra is explained. Thus, since discrete characteristics such as charge exist along with continuous characteristics such a total momentum or energy of the system, there must exist a charge operator Q_0 which commutates with the Hamiltonian of the system and, along with it, enters into the system of characteristics determining the state vector. Clearly, along with Q_0, there exists operators increasing or reducing the system's charge by 1. On this basis, the rules for their commutation with Q_0 and the so-called sum rules are derived and defined. Since the charge is conserved not only in toto but also locally, it is possible to introduce four local quantities $j_i^{\mu}(x)$ termed the current density vectors. It is shown that the commutators of not only the charges but also of their densities satisfy the same conditions as in the quark model, thus resulting in both the charge algebra and the current algebra. Since current algebra includes commutations of weak and electromagnetic currents, it is a means of deriving formulas that interrelate various cross sections or amplitudes with the participation of photons, or formulas relating weak amplitudes to weak and electromagnetic ones depending on which commutator is employed. (JPRS)

9523 FORMULATION OF BOGOLYUBOV MICROCAUSALITY PRINCIPLE AND ITS CONSEQUENCES. Lomsadze, Yu. M. pp 791-806 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The article published as Uzhgorod State University Preprint R-15 and in Ukrainskiĭ Fizicheskiĭ Zhurnal, 1966, 9, is mainly considered. (JPRS)

9524 SPECTRAL FUNCTION SUM RULES IN SU(3) X SU(3). Moffat, J. W.; O'Donnell, P. J. (Univ. of Toronto). Can. J. Phys., 45: 3901-2(Dec. 1967).

Recently derived spectral function sum rules have been used to obtain mass ratios, assuming that the spectral functions are dominated by certain low-lying states. The strangeness-carrying resonance mass ratio is investigated and the predicted value is found to depend critically upon the ratio F_K/F_π. Using the experimental value $F_K/F_\pi = 1.28 \pm 0.02$, it is found that $M_Q \approx 2.098$ Mev. On the other hand, from the input value $M_Q \approx 1.320$ Mev we get $F_K/F_\pi \approx 1$. (auth)

9525 FIXED SOURCE MODEL AND MULTIPLE PROCESSES. Gostev, V. B. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 37-42(Mar.-Apr. 1967). (In Russian).

The problem of interactions of fixed quantum fermions with bosons was resolved, and the obtained equations were used for describing multiple boson production. (tr-auth)

9526 ELEMENTARY PARTICLES. Mang, H. J. (Technische Hochschule, Munich). Bull. Ass. Suisse Elec., 58: 833-9(Sept. 2, 1967). (In German).

A sketch of the discovery of the earliest known elementary particles is given, and a table of particles and their properties lists the known particles. The quantum properties are discussed. A review of the interactions of particles and division of particles into groups as a function of their interactions are given. Resonances are treated specially after a discussion of strong interactions. Several examples are given. The problem of units smaller than the elementary particles is suggested. Further development of invariances is made using Hamilton's principle and the Lagrange function. (BBB)

9527 GEOMETRICAL QUANTIZATION APPLICATIONS. Souriau, Jean-Marie (Faculte des Sciences, Marseille). Ann. Inst. Henri Poincare, Sect. A, 6: 311-41(1967). (In French).

A previously proposed geometrical quantization method is developed and applied to several typical cases. In order to be able to treat also problems for which there is no Hamiltonian or Lagrangian formalism, the notion of dynamical structure is introduced relevant to classical or relativistic dynamics, statistical mechanics and quantization. Every dynamical structure allows among other things the assignment to each invariance group of a conjugate momentum with values in the conjugate space of the Lie algebra of the group. Following a suggestion of R. Haag, a condition on quantal measures is systematized, thus getting a formalization of the Planck condition $e = h\nu$ for all translationally invariant systems. The notion of dynamical structures allows the construction of a classical model for polarized particles. Such particles posses an intrinsic momentum of constant length j oriented by the polarization. This model turns out to be quantizable for j = half integer. For j = 0 (nonpolarized particles) one finds under the Planck condition a state space identifiable with the set of solutions of the Schroedinger equation; and in the relativistic case one finds the set of positive energy solutions of the Klein Gordon equation. For j = ½ the system is quantizable by means of spinors; Planck condition leads to the space of positive energy solutions of the Dirac equation; this removes the paradox of the nonexistence of quantal representations of the Poincaré group but instead of its covering group: this fact stems from the global topology of the dynamical structure of the corresponding particles. The case $j \geq 1$ leads to a construction similar to the "méthode de fusion" of L. de Broglie. Finally the systems of noninteracting particles (interactions are in fact incompatible with the existence of a relativistic dynamical structure) are treated. In the case of distinguishable particles the state space of the system is the tensor product of one-particle spaces. In the case of identical particles the new situation arises that quantization is possible in either of two ways one of them leading to symmetric and the other to antisymmetric states. Thus one finds a priori the existence of bosons and fermions, parastatistics being excluded-at least for the envisaged dynamical structure. At this stage of the theory the relation of spin with statistics remains unexplained. Most of these results follow from theorems in global differential geometry, notably from homotopic properties. (auth)

9528 RELATIONSHIPS BETWEEN THE MASSES OF SUB-ATOMIC PARTICLES. Lewis, D. T. (Lab. of Government Chemist, London). Nature (London), 216: 1199-1200(Dec. 23, 1967).

In previous communications the author suggested that all sub-nuclear particles are composed of x "tamaids" combined with y "bachs" according to definite quantum conditions controlled by a quantum number z, and for positively charged sub-atomic particles developed the relationship: particles external to core = $(x - 6) + y = 3 + 13z$. One of the most remarkable features of "tamaid–bach" stationary states is that experimental data support the conclusion that there can be facile interchange of "tamaids" and "bachs" between the core and the external stationary states. It is considered probable that the cores of sub-nuclear particles of positive charge contain a constant number of 6 entities, regardless of their physical nature, the stationary states containing either 3 units or successive shells of 13 unit particles, in conformity with the foregoing equation. Structures are indicated for the common mesons, baryons, etc. Structures for the muons and the π-meson are particularly interesting, since they imply the existence of "bachs" in the core. Whether the shells indicated are characteristic of true orbitals, or whether the various particles merely agglomerate in quantized layers is a matter for future speculation. The best statistical values for the rest-masses of the "bach" and "tamaid" are indicated in MeV units. It is unlikely that the bound mass of the "tamaid" remains absolutely constant, and this must affect the accuracy with which the absolute value of the mass of the "bach" can be determined. The best values for the bound rest-masses of the "tamaid" and "bach" are found to be 25.9477 ± 0.009 and 0.3277 ± 0.010 MeV, respectively. Calculated masses of the various sub-nuclear particles are given. The agreement shown with experimental values suggests that the mass defect effect produced by adding unit "tamaids" to the structure of sub-nuclear particles must be remarkably constant. (UK)

9529 HIGH-ENERGY RELATIONS FOR THE SCATTERING OF PARTICLES AND ANTIPARTICLES AND THE OSCILLATIONS OF THE SCATTERING AMPLITUDE. Bialas, A. (Jagellonian Univ., Krakow); Siciak, J.; Wit, R. Acta Phys. Pol., 32: 651-4 (1967).

The relations for high-energy scattering of particles and antiparticles, following from analyticity and crossing symmetry, are discussed for the simple case of oscillating scattering amplitudes. (auth)

9530 ELEMENTARY PARTICLES. Bransden, B. H. (Univ. of Durham, Eng.). Quart. Rev. (London), 21: 474-89 (1967).

The subject is reviewed under the following headings: Introduction; discovery of "strange particles"; classification of elementary particles; internal symmetry schemes (isotopic spin, higher symmetry schemes); search for quarks; bootstraps. (UK)

9531 CROSS-SECTION SUM RULES FOR NEUTRINO (ANTINEUTRINO) SCATTERING BY NUCLEI FROM CURRENT COMMUTATION RELATIONS. Kim, C. W. (Johns Hopkins Univ., Baltimore); Ram, Michael. Phys. Rev. Lett., 20: 35-8(Jan. 1, 1968).

Total differential cross-section sum rules for forward neutrino (antineutrino) scattering by nuclei are derived using the weak charge commutation relations conjectured by Gell-Mann on the basis of the quark model, and the closure approximation. These sum rules can now be tested with neutrino (antineutrino) beams. (auth)

Electromagnetic

Refer also to abstracts 9583, 9605, and 9700.

9532 INVESTIGATION OF $e^- + e^+ \rightarrow \mu^- + \mu^+ + \gamma$ PROCESS IN NONLOCAL THEORY TAKING INTO CONSIDERATION THE POLARIZATION OF PARTICLES. Mukhtarov, A. I.; Nadzhafov, I. M.; Abdullaev, S. K. (Azerbaydzhan State Univ., Baku). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 127-31(1967). (In Russian).

The process of $e^- + e^+ \rightarrow \mu^- + \mu^+ + \gamma$ was investigated in the nonlocal theory of interactions considering the particle polarization. General expressions were obtained for differential effective cross sections, energy and angular dependence, and for the degree of circular and linear γ quantum polarization. Comparisons were made of integral cross sections computed for local and nonlocal interactions theory (tr-auth)

9533 ACCELERATION PRODUCED ELECTRIC FIELDS IN CHARCOAL BODIES. Dunkerley, P. A. (Univ. of Kent, Canterbury, Eng.). Nature (London), 217: 52-3(Jan. 6, 1968).

It is stated that an analysis of the electrodynamics of accelerated charged bodies reveals a new method by which Einstein's principle of equivalence may be tested. If a uniformly charged spherical shell of radius $\underline{r}$ is given an acceleration $\underline{a}$ there will be within it a uniform electric field $\underline{E}$ along the direction of acceleration, the magnitude of which is given by $E = -(q/rC^2)a$. If, instead of an insulating shell, a charged conducting body of arbitrary shape were accelerated the same would hold, although the field might then be annulled by a redistribution of charge on the surface of the body. An electric field may be produced in metals in an acceleration field, and provided that the scalar potential is constant within the accelerated object the electric field produced by acceleration will be uniform and therefore conservative; the integral of electric field strength around any closed path will be zero. Permanent potential differences can be produced by placing two dissimilar metals in contact, utilizing the contact potential phenomenon. In this case non-conservative electric fields can arise from which energy can be extracted if a current flows around a suitable path. Where the field is non-conservative it cannot be cancelled by a simple rearrangement of the surface charges. If the principle of equivalence is valid, the same results as are obtained for an accelerated system should apply to a similar system supported vertically in a gravitational field. The measurement of the involved small voltages is technically feasible using superconducting limbs of low inductance and the SQUID measuring device. (UK)

9534 FORTRAN SUBROUTINE FOR CALCULATING THE RANGE-ENERGY RELATION OF CHARGED PARTICLES IN CHEMICAL ELEMENTS. Trower, W. Peter (Univ. of California, Berkeley). Contract W-7405-eng-48. J. Comput. Phys., 1: 145-7(Aug. 1966). (UCRL-11651).

A computer program was developed to give useful and accurate solutions to the problem in experimental particle physics of determining the energy loss of a charged particle as it passes through matter. The program is constructed basically to evaluate the Bethe-Bloch equation for all charged particles except electrons and positrons. At low energies shell corrections are applied. At high energies density-effect corrections are applied. It is possible to obtain the range of the particle by direct integration, using low-energy proton experimental ranges to initiate the integration. The range of a particle is given as a function of energy or momentum in terms of 3 units: cm, g-cm^2, and moles of electrons/cm^2. This calculation is made for any homogeneous target material that is a chemical element. Using the results of element calculations, the energy loss and range in chemical compounds and mixtures can be computed. The results of representative calculations agreed with experimental results. Both calculated and experimental range results for protons in Cu in the energy interval of 1 MeV to 100 BeV are shown. The user must specify the charge of the target atom, charge, and mass of the particle, and the energy range of interest. He may, in addition, specify the at. no., mean ionization potential, and density of the target material if he wishes to override the internally stored data of the program with that of his choice. (BBB)

9535 INTEGRATION OF THE SCHROEDINGER EQUATION IN IMAGINARY TIME. I. Goldberg, Abraham; Schwartz, Judah L. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Comput. Phys., 1: 433-47(Feb. 1967). (UCRL-14770-T).

Problems associated with the causal integration of the time-dependent Schrödinger equation in imaginary time are discussed, and numerical techniques for integration of the equation proposed. Because the spatial dependence of the solution in the limit of large imaginary time is that of the ground state of the Hamiltonian, the method can be applied to bound states of quantum-mechanical 3-body systems. Knowledge of the analytic dependence of the asymptotic form of the wavefunction on the trial eigenvalue was not required. For illustration, only the results for a Coulomb potential were presented, although the method presents no difficulty in the treatment of more complicated potentials, and has successfully been applied to the Yukawa and Lennard–Jones potentials as well as to higher angular momentum values in the Coulomb potential. Its real application will be found, however, in 3-body problems with 3 spatial variable. It is then possible to direct the 3 integration prescriptions, which are described, to this system, and at present the explicit form is being programmed. In addition to the methods discussed, there are other possible integration prescriptions which may be used. (BBB)

9536 TWO-PLANE WAVE INTERACTIONS IN BORN-INFELD ELECTRODYNAMICS. Barbashov, B. M.; Chernikov, N. A. pp 733-43 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

It is reported that the problem of the scattering of two plane waves in the classical electrodynamics of Born and Infeld has been solved. It turned out that the form and direction of the plane waves are unchanged after scattering. There is only a change in the phase of the wave equal to the product of the frequency and momentum of the impinging wave. It is shown that in the region of interaction, the solution becomes a multiple-valued function when the electromagnetic field exceeds a certain magnitude. (JPRS)

9537 DISPERSION SUM RULES AND MAGNETIC MOMENT OF Σ^+ HYPERON. Pisarenko, V. G. pp 488-96 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The magnetic moment of the Σ^+-hyperon is calculated from univariate dispersion relations proposed by L. D. Solov'ev (Asnawryan, Soloviev, Dispersion Sum Rules, Dubna, 1966, II; Soloviev, Dispersion Sum Rules and SU(6) Symmetry, Dubna, E-2343, I, 1965), on postulating: a definite behavior of the high-energy photoproduction amplitude; and the predominance of low-lying resonances in the dispersion sum rules. This is illustrated with a mathematical analysis of the amplitude of photoproduction of K-mesons on protons. A formula for the magnetic moment of the Σ^+-hyperon is thus derived and is shown to be in good agreement with the prediction of SU(6) symmetry. Orig. article contains: 3 figures, 43 formulas, 6 refs. (auth)

9538 QUARK MESON FIELD AND ELECTROMAGNETIC INTERACTIONS. Baldin, A. M. pp 469-80 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Attempts to consider quarks as real interacting particles having their own meson field and form factors are described in terms of existing methods of field theory. The electromagnetic structure of the nucleon is considered, and it is shown that the elementary point-quark model leads to contradictions with experiment. The introduction of an eigen structure of the quarks eliminates these contradictions. A model is considered which makes it possible to derive estimates of the cross sections of certain processes and the probabilities of resonance decay. The theoretical findings are compared with experiment. A number of difficult problems involved in the model constructed are discussed. The introduction of an intrinsic meson field for quarks eliminates contradictions between the point-quark model and the sum rules but leads to major changes in the quark model. The electromagnetic dimensions of the nucleon in the model are chiefly conditioned by the meson field of the quarks rather than by the relative motion of the quarks. Thus further investigation of the problem is needed. (JPRS)

9539 PHOTOPRODUCTION OF π^+, π^0, AND K^+ NEAR $t = 0$. Byers, Nina; Thomas, Gerald H. (Univ. of California, Los Angeles). Phys. Rev. Lett., 20: 129-33(Jan. 15, 1968).

It is shown that the coherent-droplet model with long-range π exchange can account for the observed behavior with $-t$ of the high-energy, small-momentum-transfer differential cross sections for $\gamma + p \rightarrow \pi^+ + n$, $\gamma + p \rightarrow \pi^0 + p$, and $\gamma + p \rightarrow K^+ + \Lambda$. As in n-p charge-exchange scattering, the steep rise near $-t = 0$ in $\gamma + p \rightarrow \pi^+ + n$ is the effect of long-range π exchange. The dip near $-t = 0$ in $\gamma + p \rightarrow K^+ + \Lambda$ is accounted for by the presence of large helicity-flip amplitudes. Experiments to check this are suggested. (auth)

9540 ANALYTIC PROPERTIES OF CURRENT-ALGEBRA AMPLITUDES IN THE KHURI REPRESENTATION. Mohanti, A. K. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Nuovo Cim. (10), 52A: 1361-5(Dec. 21, 1967). (UR-875-213).

The analytic properties and asymptotic behavior of weak and electromagnetic amplitudes in current-algebra sum rules are studied using the Khuri representation. The inconsistencies of the Fubini–Dashen–Gell–Mann sum rule are easily resolved. (L.B.S.)

9541 NATURAL COLLIMATION OF SYNCHROTRON RADIATION AND AXIAL DIMENSIONS OF THE ELECTRON BUNCH. Kulikov, O. F.; Yarov, A. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 94-5(Mar.-Apr. 1967). (In Russian).

A brief description is given of experiments conducted to test the assumption that, in accordance with the principle of indeterminacy, the natural collimation of synchrotron radiation is connected with a corresponding increase in the vertical spread of the electron bunch, which limits the accuracy attainable when measuring the axial oscillations of the beam (Bernardini, C. et al., Laboratori Nazionali di Frascati, 63/63, 1963). Since the indeterminacy formula, as used in the above reference, involves the wave length, it seems that photographs of the bunch through various colors of filters should show different bunch sizes. Experiments, however, revealed no such effect (they were performed on the 680-MeV synchrotron). The negative result is justified by showing that a more correct application of the indeterminacy principle no longer leads to a formula involving the wave length. (ATD)

9542 PROTON STRUCTURE AND QUASI-POTENTIAL DESCRIPTION OF THE PROTON–ELECTRON INTERACTION. Desimirov, G. M. (Univ. of Sofia); Mateev, M. D. Nuovo Cim. (10), 52A: 1366-9(Dec. 21, 1967).

The influence of the proton structure, described by a suitable form factor, on the quasi-potential of the proton–electron interaction is studied. The construction of the quasi-potential is considered using the two-time Green function; its off-shell-mass corrections are also found. (L.B.S.)

9543 THE POLARIZATION OF THE Λ^0 IN THE DECAY $\Sigma^0 \rightarrow \Lambda^0 + e^- + e^+$. Hiida, K.; Lee, Y. Y. (National Tsing Hua Univ., Hsinchu, Taiwan). Nuovo Cim. (10), 52A: 1321-7(Dec. 21, 1967).

The polarization of the Λ^0 with respect to the normal of the decay plane in the process $\Sigma^0 \rightarrow \Lambda^0 + e^- + e^+$ is re-estimated, under the assumption that C invariance and T invariance are badly violated in the electromagnetic interaction of hadrons. The value $P_\Lambda \simeq 0.84 \times 10^{-2}$ is obtained, which is consistent with experiment. (L.B.S.)

9544 ELECTROMAGNETIC MASS DIFFERENCES OF BARYONS BASED UPON THE REGGEIZED TADPOLE MODEL. Liu, Yu-chien; Okubo, S. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Nuovo Cim. (10), 52A: 1186-91(Dec. 21, 1967). (UR-875-197).

A simple calculation based upon a Reggeized tadpole model and upon Harari's once-subtracted dispersion relation gives fair agreement of baryon electromagnetic mass differences with experimental values. (auth)

9545 ARE THE HADRON ISOMULTIPLET SPLITTINGS OF ELECTROMAGNETIC ORIGIN? Flamm, D.; Majerotto, W. (Institut fuer Hochenergiephysik, Vienna). Phys. Lett., 26B: 24-6 (Dec. 11, 1967).

Due to the high anomalous magnetic moment of the quark it can be explained on a pure electromagnetic basis why the n-quark is heavier than the p-quark. It then follows, within the quark model, that all isomultiplet splittings are of pure electromagnetic origin. (auth)

9546 ON THE SOLUTION OF DIRAC'S EQUATION WITH COULOMB POTENTIAL. Kolsrud, Marius (Univ. of Oslo). Phys. Norv., 2: 43-50(1966).

The solution of Dirac's equation for an electron in a Coulomb potential is usually obtained by treating the coupled pair of first-order radial differential equations directly. The solution contains linear combinations of two confluent hypergeometric functions. To single out these functions, it is necessary to write the radial functions in a special form, which presupposes some knowledge of the character of the solution. Furthermore, to obtain the form which corresponds with the nonrelativistic limit, certain relations between hypergeometric functions must be used, and some intricate manipulations with the various constants performed. A technique was developed whereby all the confluent hypergeometric functions are obtained directly in a natural way. The first-order radial Dirac equation is squared, in two different ways, to second-order two-component equations, which are easily transformed to uncoupled confluent hypergeometric equations. The ratio between the constants of integration is found by considering the lowest terms in the transformed first-order equation. The bound and continuum states are treated simultaneously. The two methods are characterized as follows: the first yields expressions which are closely related to the nonrelativistic form. The second leads to a splitting into functions, which for the continuum states represent symptotically out- and in-going waves. (BBB)

9547 ELASTIC SCATTERING OF HIGH-ENERGY π^- MESONS ON ELECTRONS. Mukhtarov, A. I.; Muradov, R. Kh. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 2, 86-91 (1967). (In Russian).

Differential and integral cross sections of π^--meson scattering on electrons were calculated taking into account both particles and the effect of electron polarization on the cross sections. The data obtained were compared with the experimental data. Differential cross section for electron collisions with negative pions in the incoming beams were also calculated and analyzed. (R.V.J.)

9548 CONTRIBUTION TO THE STUDY OF SCATTERING BY A CENTRAL POTENTIAL IN THE DIRAC ELECTRON THEORY. Barthelemy, Marie-Claire (Institut Henri Poincare, Paris). Ann. Inst. Henri Poincare, Sect. A, 6: 365-93(1967). (In French).

A study of potential scattering in the Dirac electron theory is made. The eigenfunctions $f^{(\kappa,m)}(\theta,\varphi)$ of the operator $U = \alpha_4[(\vec{L} \cdot \vec{\sigma}) +$

$\hbar$] are investigated. It is proven that these eigenfunctions form a complete set in the sense that none can simultaneously expand four arbitrary functions of θ and φ in terms of them. The expansion of the time-independent plane wave part $a(k)e^{ikz}$ in terms of eigenfunctions of U and the phase-shifts method allow one to obtain a simple expression of the scattering cross section and of the scattering amplitude. The Born approximation is then studied for the phase-shifts. The application for the optical theorem is also discussed. (auth)

9549 POLARIZATION TENSOR OF n-TH RANK AND THE ANOMALOUS MAGNETIC MOMENT OF THE MUON. Terazawa, Hidezumi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 863-70(Oct. 1967).

A simple theorem on the photon polarization tensor of n-th rank (n even) is obtained. The proofs of it are given in two different ways: the usual perturbation theory and the LSZ formalism. The theorem is applied to the analysis of the contributions of the photon-photon interaction to the anomalous moment of the muon. A few other possible applications are discussed. (auth)

9550 PHOTOPION PRODUCTION FROM NUCLEONS. Balachandran, A. P. (Inst. for Advanced Study, Princeton, N. J. Syracuse Univ., New York); Gundzik, M. G.; Narayanaswami, P.; Nicodemi, F. Contract AT(30-1)-3399. Ann. Phys. (N. Y.), 45: 339-64(1967). (NYO-3399-114; SU-1206-114).

A study is made of the low energy behavior of the S- and P-wave multipoles corresponding to the isoscalar and symmetric isovector amplitudes for the process $\gamma + N \rightarrow N + \pi$, using certain current algebraic techniques developed in an earlier paper. All terms up to and including those which are quadratic in the pion momentum are evaluated for the real parts of the multipoles. A comparison of the techniques used with those of Chew, Goldberger, Low, and Nambu is carried out and some general conjectures regarding the current algebra approach to low-energy phenomena are presented. The difficulties encountered in extending this approach to the antisymmetric, isovector photoproduction amplitude are indicated. (auth)

9551 EXTENSION OF THE LOW SOFT-PROTON THEOREM. Burnett, T. H.; Kroll, Norman M. (Univ. of California, La Jolla, San Diego). Phys. Rev. Lett., 20: 86-8(Jan. 8, 1968).

The Low theorem is applied to the radiative cross section for unpolarized particles. It is shown that the first two terms of an expansion in the photon energy depend on the unpolarized, nonradiative cross section only. (auth)

9552 CONTRIBUTION TO THE STUDY OF SCATTERING BY A CENTRAL POTENTIAL IN THE DIRAC ELECTRON THEORY. Barthelemy, Marie-Claire (Institut Henri Poincare, Paris). Ann. Inst. Henri Poincare, Sect. A, 7: 115-48(1967). (In French).

A general study about potential scattering in the Dirac electron theory is made. The radial wave functions and other quantities relevant to the partial wave analysis of relativistic scattering theory are investigated. The properties of the solutions of the Dirac partial differential system being more difficult to obtain than those of solutions of the ordinary differential system, a partial wave analysis, similar to this one used in the nonrelativistic Schrödinger equation, is built and leads to radial equations. The analytic properties of the regular and irregular solutions of the Dirac radial differential system for a particle in the central potential V(r) are analyzed in the complex k plane. A search of analyticity of the generalized Jost functions as well as their zeros is carried out. Some properties of the S matrix lead to an analog of the Levinson theorem for the relativistic Dirac equation. (auth)

9553 REGGE POLE HYPOTHESIS IN AMPLITUDES WITH PHOTONS. Drell, Sidney D. (Stanford Univ., Calif.). Comments Nucl. Particle Phys., 1: 196-200(Nov.-Dec. 1967).

The question of whether the Regge pole hypothesis for the scattering amplitude as a function of angular momentum is applicable to photo-initiated reactions is considered. The major differences between the amplitudes for electromagnetic interactions with protons or nuclei and the amplitudes for purely hadronic interactions are pointed out. Two examples of the successful application of Regge ideas to electromagnetic amplitudes are considered, one involving the asymptotic behavior and the other the appearance of "non-sense" zeros in the residues. The example of forward Compton scattering is next discussed, in which simple Reggeism must be supplemented by a requirement of a fixed pole or a singular residue. An experimental study of the forward angle differential elastic Compton cross section at low energies is suggested. (L.B.S.)

9554 STORAGE RINGS, VECTOR MESONS, AND PHOTOPRODUCTION. Wilson, Richard (Harvard Univ., Cambridge, Mass.). Comments Nucl. Particle Phys., 1: 201-5(Nov.-Dec. 1967).

Cross sections for ρ production by photons and the $\rho\gamma$ coupling constant, which were determined from measurements of π-pair production in electron-positron colliding beam experiments, are compared with the ρ-dominance model and photo- and pion-production experiment. Photoproduction of ω and ϕ mesons is briefly discussed. (L.B.S.)

Weak

Refer also to abstracts 9540 and 9713.

9555 (CERN-67-24(Vol.4), Paper 2) K^0 DECAY. Vivargent, M. (European Organization for Nuclear Research, Geneva (Switzerland)). 36p.

A brief review of the theory of the $K^0-\overline{K}^0$ system is given. Then the experiments on violation of CP and T and the validity of the selection rules for K^0 decays are reviewed and the results related. (J.F.P.)

9556 (JEN-176-DF/I-53) CAPTURA DE MUONES POR HELIO-3 Y FUNCIONES DE ONDA DE LOS NUCLEOS DE A = 3. (Muon Capture by ^{3}He). Pascual de Sanz, Ramon (Junta de Energia Nuclear, Madrid (Spain)). Apr. 1966. 31p. (In Spanish). Dep.

The capture of a negative muon by ^{3}He in the channel $\mu_- + {}^3He \rightarrow {}^3H + \nu$ is studied. Following Primakoff the V-A theory of the weak interactions is used. Also included are first-order relativistic terms. To describe the initial and final nuclei the most general wave function allowed by the Pauli's exclusion principle was used, assuming that these nuclei are a mixture of an isospin doublet and quadruplet. For the part of the wave function depending on the internucleonic distances, four different functions were taken without a hard-core, a gaussian and three kinds of Irving type. The results obtained by varying g_V/g_A and g_A/g_V as well as the amplitudes of the fourteen terms forming the nuclear wave function are presented in several tables. (auth)

9557 (JEN-186-DF/I-57) BETA AND MUON DECAYS. Galindo, A.; Pascual, P. (Junta de Energia Nuclear, Madrid (Spain)). Nov. 195p. Dep.

Special emphasis is focussed on computational problems. A review of basic principles (Dirac equation, transition probabilities, final state interactions) is given. The four-fermion function interaction is discussed. The study of beta-decay with the main emphasis given to the deduction of the formulas corresponding to electron-antineutrino correlation, electron energy spectrum, lifetimes, asymmetry of electrons emitted from polarized nuclei, electron and neutrino polarization, and time reversal invariance in beta decay is considered. The decay of polarized muons with radiative corrections, and CVC theory are discussed. (auth)

9558 (JINR-P2-3601) MUL'TIPLIKATIVNO LI ODNO IZ LEPTONNYKH KVANTOVYKH CHISEL? (Is One of the Lepton Quantum Numbers Multiplicative?) Nguyen van Hieu; Pontekorvo, B. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 6p. (In Russian). Dep.

A neutrino experiment is suggested which allows one to determine whether a lepton quantum number, which distinguishes between the μ-neutrino and the e-neutrino, is multiplicative or additive. (auth)

9559 (JINR-P2-3603) MODEL KVARKOV DLYA NELEPTONNYKH RASPADOV, NE SOKHRANYAYUSHCHIKH CHETNOST. (A Quark Model for Parity Violating Non-Leptonic Decays). Aliev, M. K.; Struminskii, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 5p. (In Russian). Dep.

The quark model is used in order to obtain the relations between the amplitudes of nonleptonic decays of hyperons and mesons. The well known paradox related with $K \rightarrow 2\pi$ decays is resolved. (auth)

9560 GREEN'S FUNCTIONS IN THE THEORY OF QUANTUM KINETIC EQUATIONS. II. Avdonin, V. N.; Smolyanskii, S. A. (Saratov State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 122-6(1967). (In Russian).

Kinetic and antikinetic equations for a Wigner single-particle function were obtained within the limits of Green's intrinsic temperature functions for the inhomogeneous system of weakly interacting particles in a time-dependent electric field. Moreover, the kinetic equations reduced equations of motion for Green's function to satisfy conditions of causality. (tr-auth)

9561 INELASTIC SCATTERING OF ANTINEUTRINOS ON ELECTRONS. Ershov, D. K. (Smolensk State Teacher Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 118-20(1967). (In Russian).

The theory of universal weak interactions permits the existence of lepton-lepton processes: 1. $\mu \rightarrow e + \bar{\nu} + \nu$, 2. $e + \nu \rightarrow e + \nu$, 3. $e + \bar{\nu} \rightarrow e + \bar{\nu}$, and 4. $e + \bar{\nu} \rightarrow \mu + \bar{\nu}$. Theoretical studies were previously made of the first three processes. An attempt was made of calculating cross sections of the $e + \bar{\nu} \rightarrow \mu + \bar{\nu}$ process considering electron polarization in the universal Fermi interaction scheme and assuming the existence of the intermediate boson $\underline{W}$. (R.V.J.)

9562 DISTURBANCE OF CP INVARIANCE AND ELECTRIC CURRENT OF NEUTRAL PARTICLES. Berestetskii, V. B. pp 610-14 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The violation of combined parity invariance means that single-photon annihilation of a pair of identical neutral particles is possible, which means that Feynman diagrams describing the interaction of a truly neutral particle with an electromagnetic field contain vertices, that is, a current matrix should be attributed to such a particle. The structure of that current is examined in detail. (JPRS)

9563 FORMULATION OF RENORMALIZED THEORY OF WEAK INTERACTIONS AND ITS CONSEQUENCES. Vanyashin, V. S. pp 580-2 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The possibility that a weak interaction can be of a renormalizable type is considered, and it is shown that the hypothesis of a renormalizable weak interaction does not contradict theory. The advantages and disadvantages of such a formulation for weak interactions are discussed. (JPRS)

9564 ALGEBRA OF LEPTON CURRENTS. Achasov, N. N.; Muradyan, R. M. pp 574-9 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

A study is made of the possible properties of lepton symmetry by means of current algebra. The arguments indicate the possible existence of a definite hierarchy of the internal symmetries in a system of leptons, and certain basic information about the groups is presented. (JPRS)

9565 CURRENT ALGEBRA AND HYPOTHESIS ON A PARTIAL CONSERVATION OF AXIAL CURRENT. Ioffe, B. L. pp 554-66 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Three groups of assumptions used to derive the hypothesis of partial conservation of axial current are analyzed. Derivations of the results obtained by various investigators on the basis of those hypotheses are presented and compared with the experimental values. (JPRS)

9566 WEAK INTERACTIONS AND SYMMETRY. Kobzarev, I. Yu. pp 503-16 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Three questions are mainly discussed: the properties of hadron weak currents; the "soft" pion method; the rule $\Delta T = 1/2$. The hypotheses regarding weak interactions of hadrons ordinarily used are derived and the properties $g_V^{(l)}$ and g_A which follow from them are examined. The vector constants of strange decays and axial constants are discussed and the method of soft photons and $K_{\mu 3}$ decay are described. A derivation is given for the rule $\Delta T = 1/2$, based on the hypothesis of a weak dependence of amplitude on the invariants. (JPRS)

9567 NONLEPTONIC HYPERON DECAY IN THE QUARK MODEL. Miura, Kimio; Minamikawa, Toshiyuki (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 38: 954-65(Oct. 1967).

Nonleptonic hyperon and Ω^- decays are discussed in the nonrelativistic quark model and the SU(6) theory, where the pole diagram for quark, the four-body weak current-current interaction $J_1^\dagger J_3^1$ and the meson exchange interaction are considered. Two models are assumed, which can explain the experiments for parity-violating and parity-conserving amplitudes of nonleptonic hyperon decays. In particular the $\Delta I = 1/2$ rule is derived, though the weak current-current interaction $J_1^\dagger J_3^1$ does not satisfy $\Delta I = 1/2$. As to the decay of Ω^- two models predict the different ratio of $\Gamma(\Omega \rightarrow \Lambda + K)$ and $\Gamma(\Omega \rightarrow \Xi + \Pi)$. One is consistent with experiment, the other forbids $\Omega \rightarrow \Lambda + K$. (auth)

9568 A REMARK ON THE USE OF SIEGERT'S THEOREM IN μ^- CAPTURE. Bertero, M.; Passatore, G.; Viano, G. A. (Univ., Genoa). Nuovo Cim. (10), 52A: 1379-80(Dec. 21, 1967).

A recent analysis of the spectra of protons from μ^- capture by nuclei is interpreted as experimental evidence that a consequence of Siegert's theorem for nuclear electromagnetic interactions works also for the vector part of the weak interactions even at neutrino energies around 70 MeV. (L.B.S.)

9569 IS THERE A LEPTON OCTET? Christensen, R. A. (Univ. of California, Berkeley). Nuovo Cim. (10), 52A: 1038-60 (Dec. 21, 1967).

It is suggested that the leptons may exhibit the strong structure of an octet, and that the weak interactions in which they and the hadrons participate may be of a current-current form governed by a current-parity selection rule in a multidimensional eightfold way. (auth)

9570 FOUR-BODY SEMILEPTONIC DECAY OF HYPERONS AND ALGEBRA OF CURRENTS. Iwao, Syurei; Miura, Kimio (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 38: 945-53(Oct. 1967).

A study of four-body semileptonic decay of hyperons was made in the scheme of algebra of currents assuming the Cabibbo current, the partially conserved axial-vector current and the soft pion hypotheses. The S-matrix element may be approximated by the sum of the equal-time commutators of the relevant currents and single baryon terms. The $\Delta Y = \Delta Q$ rule between the initial and final hadrons admits nine electron associated decays. Three of them are highly forbidden in our approach, the other three are associated with the induced neutral current and the rest are closely related to the three-body semileptonic decays. Finally the relative rates of those decays are estimated numerically and are expected to give further information on the structure of the weak interaction when they are studied experimentally. (auth)

9571 P-WAVE DECAYS OF HYPERONS AND AXIAL VECTOR MESONS. Ozaki, Kazuhiko; Hosoda, Masataka (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 992-4(Oct. 1967).

It is pointed out that P-wave decays of hyperons are also treated by meson-dominance models, and that the amplitudes satisfy the three $\Delta I = 1/2$ sum rules as well as the Lee-Sugawara relation. (L.B.S.)

9572 CONTRIBUTION OF LEAKAGE MATRIX ELEMENTS TO THE FORM FACTORS IN K_{l3} DECAY. Mann, A. K.; Primakoff, H. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 20: 32-5(Jan. 1, 1968). (NYO-2171-236).

A theoretical expression for the form factor $f_-(t)$ in K_{l3} decay is obtained from a sum rule based on the hadron weak-current commutation relations. The "leakage" matrix elements are found to make an important contribution to $f_-(t)$. (auth)

9573 $\Delta T = 3/2$ ADMIXTURE OF NONLEPTONIC DECAYS OF K MESONS. Nieh, H. T. (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 20: 82-5(Jan. 8, 1968).

A theoretical model, which satisfactorily correlates all the $\Delta T = 3/2$ amplitudes, is presented. The implications of this model are also briefly discussed, and various meson (K) decays are considered. (J.F.P.)

Strong (General)

9574 DYNAMICAL SYMMETRIES AND THE THREE-QUARK INTERACTIONS. Werle, J. pp 666-70 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

In order to explain the existence of mesons and baryons and the fact that quark systems (e.g. qq) with fractional charges have not been observed, it is necessary to assume that forces in the $\bar{q}q$ and qqq systems are very strong and attractive, whereas the forces in the qq system must be either repulsive or at least much weaker as to prevent strong binding. The possibility that the interactions binding the qqq systems are essentially three-body interactions, which cannot be reduced to a sum of two-body terms, is pointed out. It is shown that such three-body forces are compatible with a rather high symmetry group, which excludes the existence of strong qq forces. The model is developed along lines analogous to the hydrogen atom, assuming O_4 symmetry of the Hamiltonian for the three-quark states. (L.B.S.)

9575 ATTEMPT OF FURTHER DEVELOPMENT OF NAIVE QUARK MODEL. Anisovich, V. V.; Anselm, A. A.; Gerstein, S. S. pp 661-5 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

An attempt is made to formulate a variant of the nonrelativistic quark model using the dispersion language. Most of the predictions of the model agree with the predictions of SU(6) or potential quark models. The dispersion hypothesis is used in the treatment of mesons and baryons as poles in the partial wave amplitudes of quarks. The dispersion relations are also applied to the investigation of the width and transition magnetic moment of $\omega \rightarrow \pi + \gamma$ decay. Some comments are made concerning hadron scattering. (L.B.S.)

9576 QUARKS AND HIGHER SYMMETRIES. Lipkin, H. J. pp 639-60 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

Experimental predictions for mesons and baryons are investigated on the basis of an independent quark model and higher symmetries. The approach follows that of the independent particle model in the description of nuclear shell structure, where "effective properties" for quarks in "hadronic matter" are considered. Proton-proton annihilation into two mesons, high-energy scattering and the Johnson-Treiman paradox, and the application of the independent particle model to high-energy meson-baryon and baryon-baryon scattering are treated. (L.B.S.)

9577 HADRONIC MASS SPECTRUM. Hagedorn, R. (CERN, Geneva). Nuovo Cim. (10), 52A: 1336-40(Dec. 21, 1967).

A different approach to the hadronic mass spectrum is presented, which results from the thermodynamic model and deals only with the spectral density. (L.B.S.)

9578 ON THE TESTS OF THE BASIC ASSUMPTIONS OF COMPLEX ANGULAR MOMENTUM METHOD. Kaidalov, A. B. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett., 26B: 20-3(Dec. 11, 1967).

The relations between the helicity amplitudes of the two-body processes with identical particles in the t-channel, valid for both poles and cuts in j-plane, are derived. Possible experiments to test these relations are discussed. (auth)

9579 MODEL OF ELEMENTARY PARTICLES BASED ON THE INFINITE COMPONENT FIELDS. Iwao, Syurei (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 38: 987-9 (Oct. 1967).

A model of elementary particles is presented in which the basic particle transforms as a quark state for the internal space but consists of the sets of infinite mechanical spin states differing in one-half unit from zero to infinity. The mass spectra expected from this model are briefly discussed. (L.B.S.)

Strong (Baryon No. = 0)

Refer also to abstract 9711.

9580 (CEA-R-3303) PROPRIETES D'ANALYTICITE DES AMPLITUDES D'HELICITE A DEUX CORPS. (Analyticity Properties of Two-Body Helicity Amplitudes). Navelet-Noualhier, Henri (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 135p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

Helicity amplitudes are expressed via the spinor amplitudes in terms of the Joos invariant which were shown by Williams to be free from kinematical singularities. This procedure allows one to analyze the kinematical singularities of helicity amplitudes and separate them out, which results in the definition of regularized helicity amplitudes. A crossing matrix for helicity amplitudes is written down, corresponding to the continuation path used to cross spinor amplitudes. It is explicitly verified that the corresponding crossing matrix for regularized helicity amplitudes is uniform as it should be. Kinematical constraints which generalize, to the case of arbitrary spins and masses, relations which must hold between helicity amplitudes at some values of the energy variable in $\pi N \rightarrow \pi N$, $\pi\pi \rightarrow N\bar{N}$ and $N\bar{N} \rightarrow N\bar{N}$ reactions, appear as a consequence. (auth)

9581 (IS-T-210) ON THE EFFECTS OF SPIN, SYMMETRY, AND POLARIZATION WHEN AN ISOSINGLET RESONANCE DECAYS TO FOUR PIONS. Nelson, Terence John (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 60p. Dep. CFSTI.

Thesis.

Phase-space distributions for the decay of an isosinglet resonance into four pions are developed. Such resonances were observed in the final state of the reaction $p + \bar{p} \rightarrow 2\pi^+2\pi^- + \pi^0$, for example. Of primary interest are the spin and parity of the resonance. States of four pions that observe Bose statistics and have zero isotopic spin divide into two symmetry types. The distributions are developed phenomenologically from the simplest possible T-matrix for each parity and symmetry type for spins zero and one. In general, eight variables characterize the four-particle decay problem. To facilitate the experimental determination of the spin, parity, and symmetry type, partial integrations of the distributions are performed analytically. The remaining variables are the two two-particle invariant masses of the Goldhaber triangle and angles. One of the angles orients the plane of two of the pions with respect to that of the other two. The distribution in this angle alone provides a significant partial identification of the quantum numbers of the resonance. For spin one, two more angles which specify an external direction were retained. In the reaction $p + \bar{p} \rightarrow 2\pi^+2\pi^- + \pi^0$ the resonance plus pion system was observed to be preferentially aligned with the beam direction. If production takes place equally from the four initial spin states, and if the spin of the resonance is not zero, then conservation of angular momentum along the beam direction results in anisotropy in the decay products. When available, this anisotropy is more sensitive to the spin, parity, and symmetry type than the angle between the planes is by itself. (auth)

9582 BOOTSTRAP METHOD (REVIEW). Isaev, P. S. pp 414-31 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The mathematical nature of the bootstrap method is explained along with the associated ideas that have accumulated in the course of its development. Experimental findings show that any particle (or particle pair) may be produced by the collision of any other particles. The forces arising between various particles (here the term "particle" is construed as a complex particle, i.e., as consisting of similar and other "complex particles") may differ in magnitude and hence the principal role in the structure of any particle cannot be played by all the particles but only by those particles which enter into mutual force relations of the greatest magnitude. Such is the basis of the bootstrap philosophy. The mathematical basis of this philosophy is the method of dual dispersion relations. This is illustrated with an examination of the interaction between two pi-mesons. The stability of the mathematical solution is important to the bootstrap method. The nature of this theory is, however, still not conclusively defined. One interpretation is that the universe consists of particles with given masses, spins, and other quantum numbers (charge, velocity, etc.). This universe determines the initial state. Suppose there exist certain dynamic equations (termed the bootstrap equations) which contain all these quantum numbers as parameters. If the solution of these equations results in the terminal state of these particles, a state identical to the initial state, there is a bootstrap universe. Another interpretation is that the bootstrap can only be a property of a special solution of dispersion relations and thus it is more fitting to speak of bootstrap solutions than of bootstrap equations. (JPRS)

9583 ISOVECTOR FORM FACTORS FROM ANNIHILATION AND π-π DYNAMICS. I. Bergia, S. (Istitut Nazionale di Fisica Nucleare, Bologna); Mignaco, J. A. Nuovo Cim. (10), 52A: 1381-7(Dec. 21, 1967).

A study is made on the manner through which the features of the π-π scattering influence those of the electromagnetic form factors of the nucleon. The isovector anomalous magnetic moment is first considered with a well-known dispersive formalism. For the annihilation contribution, the principle of vector–meson dominance is applied, considering the nucleon-pole contribution from the crossed channels and also N* contributions. Four models are studied for the π-π, $I = J = 1$ phase shift, using all possible experimental information. (L.B.S.)

9584 SU_6 ALGEBRA AND FOUR-PION COUPLING CONSTANT. Murtaza, G.; Sarker, A. Q. (Univ. of Islamabad, Rawalpindi, Pakistan). Nuovo Cim. (10), 52A: 1353-6(Dec. 21, 1967).

The four-pion coupling constant is determined for π-π scattering, using Adler's consistency conditions combined with the extrapolation technique of Weinberg. The magnitude is found to be quite small (0.008), which, in turn, reduces the value of the reduced matrix element corresponding to the SU_6 symmetric octet by a factor of five. (L.B.S.)

9585 φ–ω MIXING AND THE EQUALITY OF SCHWINGER TERMS. Gleeson, A. M. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Nuovo Cim. (10), 52A: 1345-7(Dec. 21, 1967). (NYO-3399-122; SU-1206-122).

A new approach to the calculation of φ–ω mixing angle is presented, in which the equality of Schwinger terms is invoked as the dynamical basis of particle mixing. It is shown that, in the mass-mixing model, the condition of equality of Schwinger terms can be used to impose an approximate nonet symmetry characterized by a high degree of mixing between the octet and singlet tensors. (L.B.S.)

9586 CALCULATIONS OF NUCLEON AND MESON MASSES. Zyong, Van Phi. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 5, 88-95(Sept.-Oct. 1966). (In Russian).

Calculations were made of the nucleon and meson masses by introducing an eight-dimensional space which consists of two subspaces: the ordinary (pseudo-Euclidean) and the inner space which is assumed to be Euclidean. After establishing the relation between Euclidean and pseudo-Euclidean 4-dimensional space and considering that the field theory in Euclidean space is free of divergences, a series of calculations made for the ordinary space are replaced by Euclidean space calculations. In order to calculate a mass of particles, a nonlinear spinor field theory was developed in the inner Euclidean space. The data obtained were in agreement with published data. (tr-auth)

9587 PION MYSTERY. Chew, Geoffrey F. (Univ. of California, Berkeley). Comments Nucl. Particle Phys., 1: 187-90(Nov.-Dec. 1967). (UCRL-17882).

The question of whether the relative low mass of the pion and its position on the spectrum indicate a special pion status is considered. Evidence arising from strong-interaction experimental data is reviewed. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstracts 9580 and 9700.

9588 (RLO-2041-1) COMPARISON OF REGGE POLE MODEL TO EXPERIMENT FOR $\pi N \to \rho N$. Hite, Gerald E. (Illinois Univ., Urbana. Dept. of Physics. Oregon Univ., Eugene. Inst. of Theoretical Science). Nov. 28, 1967. Contract AT-(45-1)-2041. 23p. (CONF-680103-2). Dep. CFSTI.

From Conference on High-Energy Collisions of Hadrons, Geneva, Switzerland.

Special attention is given to the Reggeized helicity amplitudes used to describe vector meson production. Sets of amplitudes are presented which describe all trajectories with natural parity and all trajectories with unnatural parity whose G-parity restricts the $\bar{N}N$ channel spin to be zero (e.g. Reggeized π exchange). These amplitudes have the proper kinematic singularity structure and satisfy certain threshold constraint conditions. Using these amplitudes a comparison of Regge pole theory is made to experiment for ρ production at 4.0 GeV/c and 8.0 GeV/c. A short discussion is given concerning the information on the number and types of Regge exchangers that can be obtained from experiments using polarized targets. Predictions are made of the effect of polarized targets on the decay angular distribution of the ρ meson. (auth)

9589 (LA-tr-67-111) OPTICAL MODEL OF HIGH-ENERGY ELASTIC SCATTERING AT 180°. Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from report JINR-P2-3018. 5p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

An attempt is made to describe the wide-angle elastic scattering of both negative and positive mesons (π) by protons depending on a minimum number of parameters. A curve showing the dependence of the ratio of a scattering cross section in the laboratory system of coordinates at 180° to the scattering cross section at 0° on the momentum of a bombarding meson (π) is given. It is found that this curve satisfactorily describes the basic characteristics of the meson (π) scattering at 180° as a function of energy. (J.F.P.)

9590 ELASTIC π^+p SCATTERING THROUGH 90° ANGLE AND CONTRIBUTION OF Δ_δ REGGE TRAJECTORY IN THE s-CHANNEL. Betman, R. G.; Laperashvili, L. V. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 190-3(Sept. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 707-12(Sept. 15, 1967).

The idea that resonances of the direct channel make a decisive contribution to the amplitude of elastic π^+p scattering through angles close to 90° is developed. The sum of the Breit-Wigner resonances, used in previous attempts, is replaced by the Regge formula which unifies in one term the contribution of the entire Regge trajectory on which the sequence of resonances lies. Elastic π^+p scattering through 90° is considered. (J.F.P.)

9591 RECENT PROGRESS IN MESON AND BARYON SPECTROSCOPY. Rosenfeld, A. H. pp 149-69 of Fizika Vysokikh Energii i Teriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

A review of baryon and meson spectroscopy is given. The results for the πp system are displayed in the form of partial wave amplitudes plotted in the complex plane, called Argand diagrams, and the characteristic behavior of a resonance is considered. The various resonances produced are listed and discussed. Some K + p interaction results are also considered. (J.F.P.)

9592 PION-NUCLEON SCATTERING AT LOW ENERGIES AND PARTIALLY CONSERVED AXIAL-VECTOR CURRENT HYPOTHESIS. Ishida, Kin-ichi (Yamagata Univ., Japan); Takahashi, Atsushi. Progr. Theor. Phys. (Kyoto), 38: 920-32 (Oct. 1967).

Using the axial-vector current commutation relation and the partially conserved axial-vector current hypothesis, the low-energy pion-nucleon scattering amplitudes are analyzed. For the p-wave scattering amplitudes, the (3,3)-resonance contribution which appears through the time-ordered product of the axial-vector currents is found to be the same order of magnitude as the contribution from the equal-time commutator of the axial-vector currents. By considering the (3,3)-resonance contribution, the differences between the p-wave scattering lengths are compared with experiment. The prediction prefers the Hamilton-Woolcock result to the Roper-Wright-Feld one, but it is not very conclusive. The contribution from the equal-time commutator of the axial-vector currents is shown to be essentially that from the p-meson-exchange interaction. It is stressed that the PCAC meson theory is essentially the same as the derivative-coupling meson theory in consideration of contributions both from the p-meson-exchange interaction and probably from the π-π s-wave interaction. (auth)

9593 PERTURBATION THEORY AND THE INDEFINITE METRIC. Naumov, A. I. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 29-36(Mar.-Apr. 1967). (In Russian).

The possibility of using perturbation theory in the Heisenberg variations for unique nonlinear theory of elementary particles is analyzed. It was found that perturbation theory may be used. However, instead of convolutions it was necessary to use propagators which included contributing dipole transparent states. Under such conditions the theory became renormalized (even finite) and the degeneration of the vacuum along the velocity was recorded automatically. The method was used for estimating the mass of ground-state fermion (nucleon) and a certain finite magnitude was obtained which was a function of the nonlinear Lagrangian. (tr-auth)

9594 THE ρ + R REGGE-POLE MODEL IN THE REACTION $K^- + p \to \bar{K}^0 + n$. Derem, A.; Smadja, G. (CEN, Saclay, France). Nucl. Phys., B3: 628-36(1967).

It is shown that the high-energy data for the K^-p charge-exchange scattering are in agreement with the ρ + R Regge-pole model of Phillips and Rarita. A new determination of the parameters of the model is given. The observed energy dependence of the differential cross sections is well accounted for over a wide range of energies. Evidence is found that the residue functions are all positive at $t = 0$. (auth)

9595 DETERMINATION OF THE NΛK AND NΣK COUPLING CONSTANTS FROM KN FORWARD DISPERSION RELATIONS. Davies, G. H. (Univ. of Birmingham, Eng.); Queen, N. M.; Lusignoli, M.; Restignoli, M.; Violini, G. Nucl. Phys., B3: 616-27 (1967).

Information on the pΛK and pΣK coupling constants is obtained from three types of kaon-nucleon forward dispersion relations: an unsubtracted dispersion relation for the difference of the K^-N and K^+N amplitudes, a once-subtracted dispersion relation for the K^+N amplitude, and the Haber-Schaim linear extrapolation method. The results of the various methods are in agreement with each other and imply that the values of the coupling constants are incompatible with SU(3) invariance. Some of the ambiguities which are present in the analysis are discussed. (auth)

9596 INDICATIONS OF THE ρ-LIKE SINGULARITIES IN THE COMPLEX J-PLANE. Della Selva, A. (International Centre for Theoretical Physics, Trieste, Italy); Masperi, L.; Odorico, R. Nuovo Cim. (10), 52A: 1357-60(Dec. 21, 1967).

A sum rule which is satisfied by the amplitude of the forward π-N charge-exchange scattering is presented. The sum rule relates the relevant high-energy parameters to lower-energy data, and also provides a new insight into the structure of the singularities in the complex J-plane. It is found that, besides the ρ-pole, other singularities must be present to obtain consistency, and a rough indication of their structure is obtained. (L.B.S.)

9597 AZIMUTHAL DEPENDENCE OF $\pi\pi$ SCATTERING. Grecchi, V. (Scuola di Perfezionamento in Fisica, Bologna); Turchetti, G.; Selleri, F. Nuovo Cim. (10), 52A: 1306-12(Dec. 21, 1967).

It was previously found, when the Treiman-Yang test was applied to the $\pi + N \to \pi + \pi + N$ interaction, that a strong azimuthal dependence exists in the c.m. system of the two final pions. The anisotropic population of the Treiman-Yang angle has been explained in the framework of the OPE model with absorption. An alternative explanation is presented; the anisotropy is attributed to the production of πN isobars. It is shown that a cross section for $\pi + N \rightarrow \pi + N^*$ an order of magnitude smaller than that for $\pi + N \rightarrow \rho + N$ can give rise to large (30% or more) anisotropies in the Treiman–Yang angle. This effect is large due to ρ-isobar interference. (L.B.S.)

9598 REGGE-POLE ANALYSIS OF TWO-BODY REACTIONS INVOLVING DIFFERENT MASSES AND SPINS. Mc-Kerrell, A.; Sertorio, L. (Ames Lab., Iowa). Nuovo Cim. (10), 52A: 1223-41(Dec. 21, 1967). (IS-1573).

The Reggeization procedure for two-body reactions in the general-spin case is written in compact form. The particular reaction $\pi N \rightarrow \omega\Delta$ is discussed. (auth)

9599 THE EFFECT OF A SUM RULE ON THE ρ' AND A CUT. Beaupre, J.; Sertorio, L. (Ames Lab., Iowa). Nuovo Cim. (10), 52A: 1192-1200(Dec. 21, 1967). (IS-1577).

A sum rule is used for a better evaluation of the Regge parameters of the ρ'-trajectory contribution to πp charge exchange scattering. A comparison with the cut alternative is shown. For both the ρ' and the cut, the sum rule depresses the calculated polarization. (auth)

9600 JOINT DECAY CORRELATIONS IN DOUBLE RESONANCE PRODUCTION. Donohue, J. T. (CERN, Geneva). Nuovo Cim. (10), 52A: 1152-70(Dec. 21, 1967).

The problem of correlations between decay angular distributions in double resonance production is treated, in particular for the reactions $\pi p \rightarrow \rho N^*$ and $\pi p \rightarrow f^0N^*$. It is found that in general the combined correlation effects are a priori independent of the individual decay distributions. By considering production in the forward direction, it is shown that certain combined correlation effects follow from the individual decay distributions, provided that an Adair analysis argument is valid. Such an argument is expected to hold for highly peripheral reactions in which the density matrix elements are slowly varying with production angle. Comparison with experiment is made for the ρN^* correlation, and excellent agreement is found. Suggestions for the analysis of the f^0N^* reaction are proposed, based on a sample calculation of the observed effect. The success of the absorption model in predicting the correlation is discussed, and more stringent experimental tests are suggested. (auth)

9601 $S_{1/2}$ AND $D_{3/2}$ N^* RESONANT STATES AND THEIR $N\pi$ AND $N\eta$ DECAY MODES. Davies, A. T. (Glasgow Univ.); Moorhouse, R. G. Nuovo Cim. (10), 52A: 1112-28(Dec. 21, 1967).

A review is given of the present status of the possible N^* resonance in the ηN s-state at 1500 to 1530 MeV observed in the process $\pi^- + p \rightarrow \eta + N$. An analysis is made to determine whether a large contribution to η production from an ηN decay mode of the d_{13} N^* could invalidate the previous deductions of an ηN s-wave resonance and it is concluded that present experiments sustain the ηN resonance hypothesis. The branching ratios of these two N^* resonances into πN and ηN are determined. (auth)

9602 A REGGE-POLE MODEL OF $\pi^- + p \rightarrow \eta + n$ POLARIZATION. Logan, R. K. (Univ. of Illinois, Urbana); Sertorio, L. Contract W-7405-eng-52. Nuovo Cim. (10), 52A: 1022-7(Dec. 21, 1967). (IS-1520).

Predictions of the polarization in the reaction $\pi^- + p \rightarrow \eta + n$ are made using a simple Regge pole model. The polarization arises from the interference of an A_2 Regge pole exchange in the crossed channel with direct channel resonances represented by Breit–Wigner formulae. A fit to the differential cross section in the energy range 3 to 18 GeV using constant residues is also obtained (auth)

9603 CONSPIRACIES AND FORWARD PRODUCTION OF VECTOR MESONS. Bertocchi, L. (CERN, Geneva). Phys. Lett., 26B: 27-9(Dec. 11, 1967).

It is shown that the result of Sawyer, that a conspiring Regge pole (or equivalently a Toller pole) can contribute fully to the amplitude in the forward direction, can be obtained only if the high-energy limit is performed along the boundary curve of the physical region corresponding to $\theta_s = 0$. (auth)

9604 CURRENT-ALGEBRA CALCULATION OF THE Λ TO Σ RATIO IN THE ISOSPIN-1 s-WAVE $\overline{K}N$ REACTION. Iwao, Syurei (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 38: 989-90(Oct. 1967).

The ratio of Λ to Σ in the isospin-1 state and the relevant parameters for the s-wave $\overline{K}^0p$ reaction are estimated on the basis of the algebra of currents, assuming the partially conserved axial-vector current, the soft pseudoscalar meson hypothesis, and the SU(3) symmetry. It is found that the calculation explains at least qualitatively the absorption part of the s-wave $\overline{K}N$ reaction; the large discrepancy between the theoretical value $\epsilon = 0.67$ and the experimental one 0.35 (0.32) $\overline{K}^0p(K^-p)$ remains to be explained. (L.B.S.)

9605 VALIDITY OF SUM RULES AND HIGH-ENERGY THEOREMS BY CURRENT ALGEBRA. Taguchi, Yukio; Yamamoto, Kunio (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 937-44(Oct. 1967).

Sum rules and high energy theorems by current algebra are checked by a free field (lowest order in perturbation) model. It seems that, from the commutation relations $[\int V_i^\alpha d^3x, \int V_j^\beta d^3x]$, $[\int x_iV_0^\alpha d^3x, \int V_j^\beta d^3x]$ and $[\int P^\alpha d^3x, \int P^\beta d^3x]$ no sum rule or high energy theorem can be obtained, whereas $[\int x_iV_0^\alpha d^3x, \int x_jV_0^\beta d^3x]$ and $[\int A_0^\alpha d^3x, \int A_0^\beta d^3x]$ give correct sum rules, where V_μ, A_μ, P are the vector, axial vector, pseudo-scalar currents and α, β are SU(2) or SU(3) index. (auth)

9606 SUPERCONVERGENCE RELATIONS FOR THE πN SCATTERING AMPLITUDES AT FIXED u. Iwasaki, Yoichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 38: 933-6(Oct. 1967).

Superconvergence relations for the πN scattering amplitudes at fixed u are obtained. These sum rules, which was not obtained from higher symmetry, connect the BBM coupling constant with the MMM coupling constant. (auth)

9607 ANALYSIS OF PION-NUCLEON SCATTERING AT HIGH ENERGY. Kanada, Hiroyuki; Yasuno, Masaru (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 907-19(Oct. 1967).

Phenomenological analysis of π-N elastic scattering at high energy (1 GeV/c $\lesssim P_L \lesssim$ 10 GeV/c, where P_L is the incident pion momentum in laboratory system) is made by using the experimental data on differential cross sections and polarizations in $\pi^\pm$-p elastic scattering and π^--p charge exchange process. In this analysis, it is assumed that the differential cross sections for $\pi^\pm$-p scattering are dominated with the imaginary part of the spin non-flip amplitude and one of the π^--p charge exchange process is dominated with the spin flip amplitude. First, from the experiments the imaginary part of spin flip amplitude in each scattering process is obtained and then assuming the charge independence the imaginary part in each iso-spin states, Im $\nu_{1/2}$ and Im $\nu_{3/2}$, can be obtained. The ratio of the real part to the imaginary part of the spin non-flip part in each of the processes $\alpha_\pm$ and α_c is taken from the experiments; $\alpha_+ \simeq -0.1$, $\alpha_- \simeq -0.3$ and $|\alpha_c| \sim 1$. Therefore in the frame of our analysis the ratio of the real part to the imaginary part of the spin flip amplitude $\beta_\pm$ and β_c is obtained from the consistency of the experimental data; $\beta_+ \sim -0.87$, $\beta_- \sim -0.51$, and $\beta_c \sim 1$ for $\alpha_c \sim -1$ or $\beta_c \sim -1$ for $\alpha_c \sim 1$. Furthermore, the relation of these analyses with the regularity of the mass spectrum of nucleon isobars is discussed. (auth)

9608 ONE-PARTICLE EXCHANGE MODEL OF πN INTERACTION AT 4 GeV/c. Golyak, I. G. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 17-24(July–Aug. 1967). (In Russian).

The comparison of the results of the one-particle exchange model with experimental data at 4 GeV/c showed that quasi two-particle processes do not describe all combinations of experimental data on small-ray cases; consideration of the quasi two-particle process with the formation of A_1, A_2, and B mesons leads to contradiction with experiment; on the whole the one-particle exchange model describes well the kinematic character of the secondary particles; for three-particle reactions processes of one-pion exchange play the dominant role; and with increase of the number of particles in the final state the role of ρ meson exchange increases. (tr-auth)

9609 INELASTIC MESON–NUCLEON INTERACTIONS IN THE RANGE OF 1 GeV. Golyak, I. G.; Okhlopkova, V. A.; Rus'kin, V. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 25-35(July-Aug. 1967). (In Russian).

An analysis of the experimental data on pion–nucleon interactions in the range of 1 GeV was made. It was shown that the one-pion exchange processes do not appear dominant in this energy range. (tr–auth)

9610 ONE-PARTICLE EXCHANGE MODEL OF $\pi^\pm p$ INTERACTIONS AT 2.75 GeV/c. Golyak, N. G.; Kosmachev, O. S.; Rus'kin, V. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.–Mat. Nauk, No. 4, 36–47(July–Aug. 1967). (In Russian).

A comparison was made between the results of the calculation of the cross section of the inelastic pion–nucleon interactions at 2.75 GeV/c with the experimental data. It was shown that the cross section of the quasi two-particle reaction $\pi N \rightarrow \rho N$ and $\pi N \rightarrow fN$ is approximately two times as large as that found in experiment. The cross section of the other reactions are in good agreement with experiment. (tr–auth)

9611 ρ-MESON PRODUCTION IN πN COLLISION AND THE HYPOTHESIS OF THE CONNECTION BETWEEN THE ρ MESON AND A CONSERVED CURRENT. Achasov, N. N.; Belinicher, V. I.; Samkov, L. M. (Inst. of Mathematics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 103-5(Aug. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 600-4(Aug. 15, 1967).

The production process of ρ in πN interactions is studied in the one-pion exchange model, assuming that the ρ meson is connected with the conserved isovector vector current. Contributions from a peripheral diagram and from a diagram with "radiation" of a ρ meson by a nucleon are considered. (L.B.S.)

9612 REAL PART OF SCATTERING AMPLITUDE AT HIGH ENERGIES AND DISPERSION SUM RULES. Khalfin, L. A. (Steklov Mathematics Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 107-9(Aug. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 606-8(Aug. 15, 1967).

Dispersion sum rules are derived that contain information on the real and imaginary part of the πN scattering amplitude. (L.B.S.)

9613 UNIVERSAL VECTOR AND AXIAL-VECTOR INTERACTION THEORY FOR STRONG INTERACTIONS. Pradhan, T.; Sudarshan, E. C. G.; Saxena, R. P. (Syracuse Univ., N. Y.). Phys. Rev. Lett., 20: 79-82(Jan. 8, 1968). (NYO-3399-132).

A primary universal vector and axial-vector interaction theory is proposed for strong-interaction phenomena. It is shown that such a hypothesis leads to a definite relation between vector and pseudoscalar coupling constants, which predict the S- and P-wave pion-nucleon scattering lengths, in good agreement with experiments. The ratio of π-meson to ρ-meson is also predicted, which agrees well with the observed value. (auth)

9614 CALCULATION OF πNN AND πNN^* COUPLING SHIFTS, USING THE DASHEN–FRAUTSCHI METHOD. Josephson, Nora Sigrun. Pasadena, Calif., California Inst. of Technology, 1967. 111p.

Thesis.

The Dashen–Frautschi method is applied to find shifts from SU(2) symmetry of πNN and πNN^* coupling constants. Three new features of this type of calculation are discovered. First, it is observed that the same A matrix used to connect s channel and u channel residue shifts also relates u channel contributions such as those due to γN exchange to analogous processes in the s channel. Secondly, under the assumption that all photon masses are the same (for fixed ΔI), it is noted that for linear D functions the A matrix has one eigenvalue exactly equal to one (for each ΔI), but the corresponding component of the driving term vanishes. This result depends essentially only on Clebsch–Gordan and crossing coefficients. The third discovery is that when viewed in a space of larger dimension, eigenvalues near one and "no enhancement" are easy to understand. It is also noted that when including infrared corrections, residues are not in general proportional to products of coupling constants. Since the driving terms are approximately orthogonal to the eigenvectors with eigenvalues near one, there is no simple dominant pattern, and thus the numerical results are sensitive to details which are poorly known. It is believed that the calculation gives correct order of magnitude estimates; the observable parts of the $\delta R/R_0$'s are found to be less than one percent. The experimental data are presently unclear but at least do not decisively indicate larger residue shifts than this. (Disser. Abstr.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 9655, 9700, and 9708.

9615 (INP-575/PL/PH) ELASTIC AND ALMOST ELASTIC PROTON–DEUTERON SCATTERING AT HIGH ENERGIES. Czyz, W.; Lesniak, L. (Institute of Nuclear Physics, Krakow (Poland)). 1967. 9p. Dep.

The contribution of inelastic processes to the proton–deuteron scattering cross section with a given energy resolution is estimated. (auth)

9616 (LPTHE-TH-225) COVARIANT THEORY OF THE PIONIC DISINTEGRATION OF THE DEUTERON. I. Schiff, Dominique; Tran Thanh Van, J. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Nov. 1967. 56p. Dep.

The pionic disintegration of the deuteron and its inverse process are studied in a covariant theory from threshold to 300 MeV pion kinetic energy. The singularity structure of the scattering amplitude as found from box diagrams makes it possible to select the leading contributions that come from the nucleon pole, the deuteron structure and the N N and N N π intermediate states. The latter is treated as an N N^* state where N^* is the (3,3) pion nucleon resonance. Dispersion relations are written for partial wave amplitudes and the contribution of the N N^* state to unitarity is explicitly calculated, taking into account the spin and the instability of N^*. The nucleon-nucleon interaction and the pion-nucleon S wave are first neglected; later these contributions are evaluated. A detailed comparison in the medium energy region shows a good agreement with the existing data. (auth)

9617 RADIATIVE PION CAPTURE AND AXIAL CURRENTS IN NUCLEI. Ericson, M.; Figureau, A. (Inst. de Physique Nucleaire, Lyon). Nucl. Phys., B3: 609-15(1967).

The PCAC hypothesis is used to generalize the Kroll-Ruderman theorem of threshold photoproduction on nucleons to the case of light nuclei and to express the result in terms of nuclear axial matrix elements. The (^{3}H,t) system is studied in more detail including various higher order effects. A Panofsky ratio of 2.70 is obtained as compared to the experimental value of 2.28 ± 0.18. (auth)

9618 COVARIANT THEORY OF PION–DEUTERON ELASTIC SCATTERING. Schiff, D.; Tran Thanh Van, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., B3: 671-709(1967).

The elastic pion-deuteron scattering is studied in a fully covariant theory in which special attention is given to the treatment of inelastic unitarity. From a study of the box diagram singularities, the leading contributions are found to come from the impulse graphs, i.e. the two-pion exchange in the t-channel and the nucleon-nucleon and the pion-nucleon-nucleon intermediate states in the s-channel. The πNN state is approximated by an NN^* state and the instability of N^* is taken into account. The correction terms are due to the binding, multiple scattering and absorption processes. These effects have been calculated and dispersion relations for the partial wave amplitudes are used. A detailed comparison with experiments for pion energy in the lab system at 85, 142, 300, and 330 MeV shows an excellent agreement. (auth)

9619 ESTIMATE OF Λ NUCLEAR POTENTIAL-WELL DEPTH. Bhowmik, B.; Chand, T.; Chopra, D. V. (Univ. of Delhi). Nuovo Cim. (10), 52A: 1375-8(Dec. 21, 1967).

An attempt is made to determine the Λ nuclear potential-well depth (D_Λ) from the Λ binding energy (B_Λ) of mesonically decaying heavy spallation hyperfragments. Only the π-p-recoil decays from the world sample of heavy hyperfragments are considered. The values of D_Λ obtained for each event are tabulated. (L.B.S.)

9620 ANGULAR DISTRIBUTION OF p-p SCATTERING AT HIGH ENERGY. Armoudian, G. A. (Columbia Univ., New York). Contract AT(30-1)-1932. Nuovo Cim. (10), 52A: 1328-32 (Dec. 21, 1967). (NYO-1932(2)-125).

A previous analysis of p-p interactions indicated the possibility of approximating the full p-p elastic amplitude in terms of several Born terms which have the effective potential U(x) obtained by shifting the singularity from $x^2 = 0$ of the propagator in the usual theory. Calculations are carried out of the angular distributions and the cross sections and are compared with the data. (L.B.S.)

9621 ON THE SOLUTION OF THE FADDEEV EQUATIONS IN THE CASE OF LOCAL TWO-BODY INTERACTIONS. Bierter, W. (Univ., Basel); Dietrich, K. Nuovo Cim. (10), 52A: 1209-22 (Dec. 21, 1967).

The quasi-particle method of Weinberg is used to obtain solutions of the Faddeev equations in case of local two-body interactions. Calculations are carried through for the case of a linear model of nucleon–deuteron scattering and square-well interactions are used. The validity of various approximations like the "pole approximation" is discussed. It is found that the 3-particle scattering matrix depends sensitively on the off-the-energy-shell behavior of the two-particle T-matrices. (auth)

9622 ELASTIC BARYON–BARYON SCATTERING IN THE QUARK MODEL. Dare, D. P. (Univ. of Sussex, Eng.). Nuovo Cim. (10), 52A: 1015-21(Dec. 21, 1967).

Sum rules for elastic baryon–baryon cross sections are calculated using the quark model allowing for spin-dependent forces. These are compared with earlier predictions obtained from the spin-independent quark model, and the SU_6 symmetry scheme. (auth)

9623 COMPOUND STRUCTURE MODEL FOR THE P_{11} RESONANCE AND THE SHIFT OF ITS MASS IN THE pp → pN^* REACTION. Kobayashi, Tsunehiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 990-2(Oct. 1967).

A previous experiment on the p + p → p + N^* interaction showed that the peak of the P_{11} resonance production in the missing mass distribution shifts from 1400 to 1500 MeV as momentum transfer increases. The simplest case that the P_{11} is constructed from two resonances is treated. (L.B.S.)

9624 NUCLEON–NUCLEON POTENTIAL OF ONE-BOSON-EXCHANGE TYPE. Kishi, Yosuke (Kyoto Univ.); Sawada, Shoji; Watari, Wataro. Progr. Theor. Phys. (Kyoto), 38: 892-906(Oct. 1967).

A phenomenological energy independent nucleon-nucleon potential is proposed, which has a form corresponding to the one-boson-exchange model. For the exchanged bosons, scalar bosons of mass 540 MeV and vector bosons of mass 750 MeV are considered in addition to the pion. The potential parameters which satisfactorily reproduce the experimental data on the proton-proton and the neutron-proton systems below 350 MeV are determined. From the potential parameters thus determined, coupling constants of bosons with nucleon are estimated and it is found that they have the values similar to those obtained in other analyses. (auth)

9625 KINEMATICAL CALCULATION OF Λ-NUCLEON STIMULATION REACTION FOR HYPERFRAGMENTS OF MASS A = 50. Ganguli, S. N.; Swami, M. S. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 66: 77-86 (Aug. 1967).

Energy spectra of fast protons ($E \geq 30$ MeV) were calculated for hyperfragments of mass A = 50, from Λ-proton and Λ-neutron stimulation processes respectively. It was concluded by comparing with the experimental energy spectrum, that Λn/Λp stimulation ratio is ~5. It was estimated, from this ratio, that the emission frequencies of two fast protons, from Λ-single nucleon stimulation, both with $E \geq 20$ MeV and with $E \geq 30$ MeV, are ≈3.3% and ≈1.7% respectively. (auth)

9626 K^+d STRUCTURE IN I = 0 AT 1.2 GeV/c AS A RESULT OF S-STATE $K \rightarrow K^*(890)$ CHANNEL COUPLING. Krammer, Margarete (Deutsches Elektronen-Synchrotron, Hamburg); Lomon, Earle L. Phys. Rev. Lett., 20: 71-3(Jan. 8, 1968).

A well-defined peak was reported in the $K^+ + d$ total cross section at 1.2 GeV/c K^+ laboratory momentum. Subtraction of the $K^+ + p$ cross section and making the Glauber correction for screening leaves an I = 0 peak of approximately 6 mb above background and a width of about 150 MeV. It is reported that a previous fit to the data below 800 MeV/c contains a prediction of this experimental peak. It is concluded that the observed I = 0, $K^+ + N$ peak at 1.2 GeV/c can be understood as an S-state peak on top of a smoothly decreasing background. Also the behavior of the I = 0, S-state phase shift below K^* threshold implies just such a peaking. The coupled-channel boundary-condition model fitted to the data below threshold provides an adequate, or almost adequate, extrapolation to the peak region. (J.F.P.)

9627 PROTON–PROTON BREMSSTRAHLUNG. Marker, David George. University Park, Pa., Pennsylvania State Univ., 1966. 171p.
Thesis.

In order to investigate the off-energy-shell behavior of phenomenological two-nucleon potentials, off-energy-shell K-matrix elements and proton-proton bremsstrahlung cross sections have been calculated from four fundamentally different models. These included: (1) hard core plus strong attraction of Hamada–Johnston and Brueckner–Gammel and Thaler (BGT); (2) soft core plus weak attraction of Bressel, Kerman, and Lomon (BKL); (3) weak, momentum dependent potential of Green (G) (in the S-wave only); and (4) non-local, separable potential of Tabakin (TAB). K-matrix elements of these potentials have been calculated for energies of the incident proton of 50, 100, 150 MeV, and for values of χ, the ratio of final to initial center of mass momenta, of .2-2.0. At 50 MeV, the behavior of all four as a function of χ is nearly the same while at 150 MeV there are greater differences especially in the $^3P_0$ state. (BKL and HJ are nearly the same; both differ appreciably from TAB) in this state. The results of ppγ cross-section calculations at 46 and 158 MeV are presented and compared with the experiments of Warner, Richardson, and Gottshalk. At 46 MeV, all models give approximately 7 $\mu b/ster.^2$ for $d\sigma/d\Omega_1\, d\Omega_2$ while at 158 MeV, HJ and BKL predict 11 $\mu b/ster.^2$ and TAB, $\mu b/ster.^2$ Agreement of theory with experiment at 158 MeV is excellent for HJ and BKL but at 46 MeV, the predictions are too large by a factor greater than two. Both the Coulomb interaction and double scattering correction have been omitted from these calculations and when included, better agreement may be obtained at the lower energies. (Disser. Abstr.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 9032 and 9703.

9628 REPRESENTATION OF CURRENT-DENSITY ALGEBRAS IN ONE-PARTICLE SPACES. REPRESENTATION THEORY. Ruehl, W. (CERN, Geneva). Nucl. Phys., B3: 637-54(1967).

A study is made of representations of charge-density algebras in one-particle spaces which allow the internal symmetry to be split off. These representations are shown to be reducible into two parts, the first of which consists of operators which do not depend explicitly on the momentum. If this part is void, the form factors of the particles involved in the representation can be shown to satisfy a master equation. For a certain subclass of representations this equation reduces to a set of second-order integral identities for the form factors. (auth)

9629 A GENERAL ANALYSIS OF THE DYNAMICAL SYMMETRIES OF THE N-DIMENSIONAL HARMONIC OSCILLATOR. Maiella, G. (Univ., Naples). Nuovo Cim. (10), 52A: 1004-14(Dec. 21, 1967).

It has been recently claimed that SU_n and O_{n+1} symmetries are intrinsically possessed by all classical dynamical systems involving n degrees of freedom. The significance of an "invariance dynamical group" and the connections with the classical degeneracy and the one-valuedness of the constants of motion are clarified. It is demonstrated also that SU_n is the "invariance group" of the n-dimensional harmonic oscillator only if the motion is completely degenerate, while O_{n+1} is never an "invariance group" of the harmonic oscillator. (auth)

9630 A SYSTEMATIC SEARCH FOR NONRELATIVISTIC SYSTEMS WITH DYNAMICAL SYMMETRIES. PART I. THE INTEGRALS OF MOTION. Makarov, A. A.; Smorodinsky, J. A.; Valiev, Kh.; Winternitz, P. (IAEA, Trieste, Italy). Nuovo Cim. (10), 52A: 1061-84(Dec. 21, 1967).

A general discussion is given of so-called accidental degeneracy and the corresponding dynamical invariance groups in quantum mechanics. The existence of pairs of commuting integrals of motion not higher than second order in the derivatives is considered and related to the separation of variables in the Schrödinger equation. All Hamiltonians are found which allow three of four integrals of motion, two of which are related to the angular momentum and its projection. (auth)

9631 ON TRANSFORMATIONS BETWEEN BASIS VECTORS OF UNITARY $SL_{2,C}$ REPRESENTATIONS. Delbourgo, R.; Koller, K.; Mahanta, P. (Imperial Coll. of Science and Tech., London). Nuovo Cim. (10), 52A: 1254-73(Dec. 21, 1967).

A "physicist's" version is presented of the decomposition procedure for obtaining the principal series of $SL_{2,C}$ representations as a direct sum or integral over unitary representations of the subgroups $SU_{1,1}$ and $U_1 \ltimes T_2$ by the method of induced representations. This procedure corresponds to the passage from the standard base vectors, which are labelled by the SU_2 subgroup, to new base vectors labelled by the noncompact subgroups. The representatives of general finite boosts between any of these bases were determined; among other things these yield the transformation functions connecting the three types of states, in the zero-boost limit. (auth)

9632 WAVE EQUATION WITH MASS AND SPIN SPECTRUM BASED ON O(3,3) GROUP FOR RELATIVISTIC DEFORMABLE MODEL. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 966-86(Oct. 1967).

On the basis of the fact that the group SL(4,R) of relativistic linear deformation and rotation is isomorphic to SO(3,3), new transformation properties under the physical Lorentz transformation is assigned to the internal coordinate in the bilocal-type model, which is adopted as a simple relativistic example having internal movement. The new viewpoint leads to both integer and half-integer spin states and also to the first order wave equation, which contains a mass spectrum corresponding to infinite-dimensional representations of the inner Lorentz group. On the other hand several versions of bilocal model which belong to the conventional identification of inner Lorentz group and represent oscillator or rotator type internal motion are successively discussed in the Appendix. (auth)

9633 SUBTRACTIONS IN A DISPERSIVE APPROACH TO INTERNAL SYMMETRY BREAKING. Segre, Gino (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 20: 29-31(Jan. 1, 1968).

It is shown how the subtractions, in a dispersive approach to SU(3) and SU(2) breaking, reproduce the results of the tadpole model, under the assumption of certain widely used forms for the medium-strong interaction. (auth)

9634 CLEBSCH–GORDAN OR WIGNER COEFFICIENTS. Brussaard, P. J. (Univ., Utrecht). Ned. Tijdschr. Natuurk., 33: 202-22(July 1967). (In Dutch).

Considering that the Wigner coefficients can all be defined by a quantum mechanical system, the necessary quantum mechanical properties of the moment of momentum are given. The quantum mechanical composition of the moment of momentum and the definition and calculation of the Wigner coefficients are outlined. The 3j symbols of Wigner, equivalent to the Wigner coefficients, are defined. The classical limits of the Wigner coefficients are given, and some applications are given. The Racah coefficients of the 6j symbols are defined, and their application is described. A short description is given of the classical limit of the Racah coefficient. Complex 3n-j symbols are briefly considered. (tr-auth)

9635 FIZIKA VYSOKIKH ENERGI I TEORIYA ELEMENTARNYKH CHASTITS. (High-Energy Physics and Elementary Particle Theory). Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. 816p. (In Russian and English).

There were 57 lectures included, seven of which were abstracted previously in NSA. For abstracts of these lectures see abstract numbers: 20: 2758, 20: 30059, 20: 36035, 21: 4038, 21: 5373, 21: 11785, and 21: 15371. A separate abstract was prepared for each of the remaining 50 papers. (J.F.P.)

For abstracts of individual sections see: 9032, 9034, 9522, 9523, 9536–9538, 9562–9566, 9574–9576, 9582, 9591, 9636–9645, 9647–9653, 9656–9664, 9673–9676, and 9703–9705.

9636 EXTENDED SYMMETRY, UNITARITY, AND FERMI STATISTICS. Matthews, P. T. pp 173-82 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

The relation between internal and relativistic invariance is discussed in general terms, and then the achievements and limitations of U(12) and related theories are considered in this light. The apparent paradox in the role of the homogeneous Lorentz group, which is a noncompact group with nonunitary finite representations (but the familiar fields ϕ_a, A_μ, and $F_{\mu\nu}$ are each finite representations of the homogeneous Lorentz group and their introduction seems to be the crucial step in the whole development) is analyzed. Extended symmetries are introduced through the notion of index invariance, and it is shown that this is only compatible with the unitarity of the S-matrix for infinite unitary multiplets (spin towers). It is also shown that one cannot construct causal fields for such towers satisfying Fermi statistics. (J.F.P.)

9637 UNITARY REPRESENTATION OF NONCOMPACT GROUPS. Naimark, M. A. pp 183-215 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The lectures presented deal not with the general theory of these representations but only with the unitary representations of two groups: the SL(n,C) group (i.e., the group of all complex n-th order matrices with a unity determinant) and the pseudounitary group U(p,q) (i.e., the group of all nondegenerate linear transformations of the complex p + q-variate space). These two groups are of the greatest interest to physicists; thus, e.g., the SL(n,C) group is in a sense a model of semi-simple complex Lie groups. The so-called method of induced representations is examined for constructing the representations of these groups. A representation is termed unitary if the scalar product of (x,y) invariant with respect to all the operators of the representation can be introduced into the space E of the representation. (JPRS)

9638 IRREDUCIBLE REPRESENTATION OF LIE GROUP ALGEBRA U(p,q). (DESCRIPTION OF DISCRETE CONCEPT SERIES). Gel'fand, I. M.; Graev, M. I. pp 216-26 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The group U(p,q) is the group of all the complex linear transformations n = p + q of the variables $z_1, \ldots, z_n$, retaining a Hermitian form. When q = 0, U(p,q) is a group of unitary matrices and when q > 0, U(p,q) is noncompact and all of its irreducible unitary representations are of infinite dimension. A discrete series of irreducible representations of the Lie algebra L(p,q) of the group U(p,q) rather than of this group itself is described. It is shown that, given a rational specification of the base in space for the representation of the discrete series, the Hermitian-form algebras L(p,q) are specified by the same formula as the representation of the Lie algebra L(n,0) for the group of unitary matrices. The irreducible representations of the algebra L(n,0) are described with Hermitian operators. Although a very close relation exists between representations of a group and representations of its Lie algebra, a description of group representations cannot be directly derived from a description of its Lie algebra representations. (JPRS)

9639 DISCRETE SYMMETRIES PROBLEMS. Wick, G. C. pp 227-36 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

An attempt is made to clarify some questions in the application of group theory to the symmetry laws of nature. It is shown that certain problems which arise in connection with the so-called discrete symmetries (P,T,C, etc.) are related to the theory of "group extensions." In the first lecture the direct product is defined, and it is pointed out that the internal symmetry group does not form a direct product with the geometrical group of the space inversion. An example is given in quantum electrodynamics, which illustrates that the problem of mixing an internal symmetry with a group of coordinate transformations may have other solutions than the direct product. The problem of extension of the group SU(3) by the operation of charge conjugation is also examined. Questions concerning the connection between the internal symmetry group and the discrete operations P and T of the Poincare group are dealt with in the second lecture. (L.B.S.)

9640 NONCOMPACT GROUPS AND DYNAMIC SYMMETRY. Todorov, I. T. pp 237-57 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Group-theory methods in the theory of elementary particles which have not yet found application in the physics of strong and electromagnetic interactions are considered. The symmetry of each type of interaction is examined. Emphasis is placed on the formal aspect of this matter, namely, on mathematical methods, in the belief that the theory of unitary representations provides the natural language in which the theory of elementary particles and quantized fields will eventually be formulated. An elementary introduction to the theory of representations of noncompact groups and the concept of dynamic symmetry with classical examples of this concept (the hydrogen atom, etc.) are given. Attempts to classify hadrons as a discrete series of unitary (infinite-dimensional) representations of the U(6,6) group and "candidates" for the dynamic symmetry of elementary particles (including the Poincare and U(6,6) or SL(6,C) groups are discussed. (JPRS)

9641 UNITARY REPRESENTATION OF GENERALIZED POINCARE GROUP. Novozhilov, Yu. V.; Terent'ev, I. A. pp 275-95 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The successes of nonrelativistic SU_6 symmetry as well as certain accomplishments of relativistic symmetry based on groups of the SL(n,c) and U(n,n) type indicate that the symmetry of elementary particles may be associated with generalized Poincare groups. This raises the problem of constructing unitary representations of generalized Poincare groups. The problem of an explicit construction of unitary representations of the inhomogeneous groups ISL(n,c) and IU(n,n) as based on an investigation of the momentum space of ISL(n,c) and an elaboration of the method for the calculation of Wigner's operator are presented. The basic equations for matrices in the fundamental representation, group relations associated with momenta, the construction of Wigner operators for the aforementioned groups, arbitrary transformations of ISL(n,c), and calculations for the case of the group IU(2,2) are covered. Further, the question of generators in unitary representations and Dirac-type equations is briefly discussed. It is shown that the formulas derived for the Wigner operator may also be regarded as a solution of an equation of the Dirac or Gel'fand-Yaglom type. (JRPS)

9642 GROUP STRUCTURES WITH INTRINSIC MASS SPLITTING. Uhlmann, A. pp 313-17 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

Examples of group structures with intrinsic mass splitting are described, and some explanation is given on how these structures may occur. In particular, the Werle-Formanek structures and a possible connection with currents are discussed. (L.B.S.)

9643 LADDER REPRESENTATIONS OF U(N,N) ALGEBRAS. Olszewski, J. pp 318-35 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

The ladder representations for non-compact algebras of the U(N,N) type are explicitly constructed in the basis in which all physical quantities (such as spin, isospin, hypercharge, etc.) are diagonal. The reduction of representations of U(N,N) with respect to compact subgroups $U(N) \otimes \overline{U}(N)$ and $SU(N)_J$ is considered and the $SU(N)_J$ multiplet structure of these representations is shown. Finally, the construction of these representations in the cases of U(2,2) and U(3,3) is briefly sketched, and mass formulas obtained for U(3,3) are presented. (L.B.S.)

9644 ON THE REPRESENTATION OF INFINITE-DIMENSIONAL LIE ALGEBRA A(P,S). Votruba, J.; Havlicek, M. pp 330-5 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

The construction of the Lie algebra, which gives the classification of particles with internal quantum numbers, and also includes nontrivially masses and spins, is considered. The example of the infinite-dimensional Lie algebra in which this classification is possible, is given, and its construction is shown. Also the construction of one class representations of the algebra I(P, SU(2)) is briefly described. (J.F.P.)

9645 A NUCLEAR PHYSICIST'S VIEW OF SOME RESULTS OF CURRENT ALGEBRAS. Lipkin, H. J. pp 567-73 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967.

It is shown that many results that have been obtained from the assumption that space integrals of the time components of vector and axial-vector currents satisfy the commutation rule of the Lie algebra U(3) × U(3) can also be obtained using simple algebraic techniques. In particular, general formulas are obtained for the matrix elements of the axial-vector currents. (L.B.S.)

Applications (Electromagnetic and Weak)

Refer also to abstract 9555.

9646 (LPTHE-TH-224) TCP INVARIANCE, TIME-REVERSAL INVARIANCE, AND K-MESON DECAY. Gourdin, M. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Nov. 1967. 46p. Dep.

A discussion of the existence of possible discrete symmetries in connection with meson (K) decay is presented. The quantum mechanical treatment of the $K^0\bar{K}^0$ complex is briefly reviewed without additional symmetry. In particular, the unitary relation is derived as a consequence of the conservation of probabilities. The general features of TCP invariance and T invariance are discussed. Special attention is given to the 2π mode where the violation of PC invariance was measured. The consequences of TCP invariance for which the problem is completely determined and has two solutions are given. Finally, a rapid scheme for the interpretation of the $K \rightarrow 3\pi$ experiments is presented. (J.F.P.)

9647 DYNAMIC SYMMETRY IN QUANTUM MECHANICS. Alliluev, S. P.; Matveenko, A. V. pp 695-701 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

An example of a physical system whose complete symmetry group is not reduced to the purely geometric—the molecular hydrogen ion H_2^+, and the more general problem of movement of an electron in a field of two different Coulomb centers is considered. That group is broader than the initial geometric group. In the terms of that group the Neuman-Wigner theorem proves to be applicable also to the molecular hydrogen ion. (JPRS)

9648 BARYON DECAY FORMING DALITZ PAIRS. Valuev, B. N. pp 615-21 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The process $B_1 \rightarrow B_2 + e^- + e^+$, where B_1 and B_2 are baryons (or antibaryons) with spin $\frac{1}{2}$ is examined. In a band (single-photon) approximation the measured values are expressed by 4 form-factors needed to describe the process. The expressions obtained can be useful for a detailed verification of CP-invariance in such cases as $\Sigma^+ \rightarrow pe^-e^+$. General formulas in which the electron mass was not neglected are also applicable to decays with formation of a pair of mu-mesons. (JPRS)

9649 ON THE POSSIBLE MECHANISM OF NON-CONSERVATION OF CP. Arbuzov, B. A.; Filippov, A. T. pp 597-609 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Possible mechanisms of nonconservation of combined parity are discussed, and a geometric approach is used in an attempt to introduce a temporary bridge between weak and electromagnetic interactions by introducing a hypothesis for the geometric nature of the electrical field and certain other more or less natural and simple hypotheses. Thus the observed corollaries are derived, one of which is violation of CP-invariance in certain interactions of particles with an electromagnetic field. It is very important now to search for effects of nonconservation of CP and T in lepton and semilepton decays of hadrons and radiative decays of K-mesons and baryons, and also to search for the decays $K_2^0 \rightarrow 2\pi^0$ and $K_2^0(K^{\pm}) \rightarrow \pi^0(\pi^+)e^+e^-$. (JPRS)

9650 POSSIBLE DISTURBANCE OF CP INVARIANCE. (REVIEW OF EXPERIMENTAL DATA). Okonov, E. O. pp 585-96 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

A survey of experimental data on combined parity invariance is presented. The decay $K_L^0 \rightarrow \pi^+\pi^-$ still remains the only recorded effect of violation of CP-invariance, and although most attempts to save combined parity have proven fruitless, in principle one cannot exclude the possibility that one is dealing with still unknown specific properties of K^0-mesons, and therefore experiments with other particles are necessary. The question of the mechanism of the violation of CP-invariance remains unanswered. (JPRS)

9651 HIGH LEPTON SYMMETRY AND W BOSON. Kadyshevskii, V. G. pp 541-53 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Certain applications of group theory for the classification and description of lepton interactions are examined. Attention is concentrated on group 0(5) on the assumption that it correctly describes the internal symmetry of leptons. To explain that assumption, the symmetry properties of the weak and electromagnetic interactions of leptons are examined in detail. (JPRS)

9652 ELECTROMAGNETIC INTERACTIONS AND UNITARY SYMMETRY. Solov'ev, L. D. pp 451-68 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Predictions which SU(6) symmetry provides in relation to the electromagnetic properties of hadrons, are considered along the lines of dispersion relations and current algebras. The principal electromagnetic processes corresponding to a three-particle vertex are considered, and it is explained what is given for them from SU(6) symmetry, dispersion sum rules, the Fubini method (charge algebra), and current algebra. (JPRS)

9653 COLLINEAR GROUPS OF SU(3) x SU(3) AND SU(6)w AND THEIR USES WITH STRONG AND ELECTROMAGNETIC INTERACTIONS OF HADRONS. Volkov, D. V. pp 394-407 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The consequences of the symmetry of collinear groups as applied to strong and electromagnetic interactions of hadrons are examined in detail. It is shown that the symmetry type involved in SU(3) × $\mathrm{SU(3)}_{\mathrm{coll}}$ groups corresponds to two independent SU(3) transformations of states with different spirality, i.e., indeed to symmetry of the SU(3) × SU(3) group. The known formula for magnetic form factors of the neutron and proton also is a consequence of this group. In the case of the $\mathrm{SU(6)}_w$ group the comparison of predictions with experiment must be somewhat tentative, since this symmetry is a disturbed symmetry. The utilization of this group to determine the relative probability of decays of the higher resonances may be useful for the classification of these resonances with respect to supermultiplets. (JPRS)

9654 POSSIBLE NATURE OF CP-NONINVARIANCE OF WEAK INTERACTIONS. Shabalin, E. P. JETP Lett. (USSR) (Engl. Transl.), 6: 140-2(Sept. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 648-50(Sept. 1, 1967).

CP violation of weak interactions is studied on the basis of current algebra. Starting from the theory with charged currents, the interaction of neutral currents is obtained, which leads to a CP-parity violation of the order of $G^2\Lambda^4/(2\pi)^4$. (L.B.S.)

9655 PARITY-VIOLATING NUCLEAR FORCES. Okun, L. B. (Academy of Sciences, Moscow). Comments Nucl. Particle Phys., 1: 181-6(Nov.-Dec. 1967).

The significance of investigating the P-violating nuclear forces as a test of the theory of the universal weak interaction is pointed out. Experimental results of nuclear reactions with cadmium, tantalum, and lutetium are summarized. It is suggested that investigation of the $n + p \rightarrow d + \gamma$ reaction would allow the establishment of the isotopic-spin dependence of the parity-violating nuclear force. (L.B.S.)

Applications (Strong)

Refer also to abstracts 9574, 9576, and 9653.

9656 THEORY OF ELEMENTARY PARTICLE SYMMETRY. Bogolyubov, N. N. pp 5-112 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

In view of the increasing number of newly discovered elementary particles, including the so-called resonances, i.e., particles whose lifetime is roughly only one order of magnitude greater than the corresponding nuclear time, the concept of the elementary particle has lost its original meaning has become largely conditional. In this connection a series of lectures describing attempts to compile a distinctive "periodic table" of elementary particles is presented.

The theory of symmetry is assessed from the standpoint of the quark model with respect to the SU_3 group as based on the principle of additiveness. The masses of the resonances considered, when tabulated, are found to be equidistant: the difference in mass is proportional to the difference in hypercharge. It is shown that the Pauli principle is not satisfied for quarks. The existence of as many as three identical quarks with identical spins at a single energy level is postulated. The parafermion nature of quarks is suggested. (JPRS)

9657 MASS SPECTRA OF HADRONS IN DYNAMIC GROUP. Stoyanov, D. Ts.; Todorov, I. T. pp 258-62 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

A semi-phenomenological operator of the square of mass m^2 is constructed as a function of a small number of arbitrary constants; this operator describes the splitting of mass within each infinite multiplet of the U(6,6) group. Then, of course, m^2 does not coincide with the square of momentum k commutating with the U(6,6) group and the concept of a generalized "dynamic" momentum p which does not commutate with the spin is introduced. Then m^2 is defined as an invariant quadratic function of p and p', where p' is derived from p. The particle state vectors are determined as the eigenfunctions of the operator m^2, transformable with respect to staircase representations of the U(6,6) group. They are sought in the quiescent system of the k vector as a series of irreducible representations of the compact group $U(6) \otimes U(6)$. The first approximation for the 56-plet of baryons gives satisfactory agreement with experiment. In the meson case, the operator m^2 gives equality between the masses of particles and antiparticles. For the meson 36-plet, however, the quantitative agreement between the first approximation and experiment is not as good as in the baryon case. Mass formulas for baryons and mesons are presented. (JPRS)

9658 EXPANSION OF FINITE GROUPS AND INTERACTIONS OF ELEMENTARY PARTICLES. Mozzhimas, Ya. pp 336-8 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Currently the symmetries of strong interactions are described by means of continuous groups. This raises the question of whether these symmetries could not be described with finite groups instead. In this connection, the tracing of the existence of a relation between the maximum transitiveness of finite groups and the number of elementary-particle interactions is discussed. If the condition of maximum transitiveness for a minimum number of base fields is satisfied then each interaction converts any base field to any other base field, assuming the existence of n indistinguishable base fields $\psi_1, \ldots, \psi_n$. It is shown that there do not exist any groups with a transitiveness number $k > 5$, but there exist classes containing an infinite multitude of k-tuply transitive groups for $k = 1, 2, 3$. The question asked above can be answered only by further investigating the group M_{12} (the symmetry group of all five interactions between the base fields $\psi_1, \ldots, \psi_{12}$). Such an investigation is not a simple problem, however, considering that M_{12} is a group with a considerable diversity of symmetry (the number of elements of this group is 95040). A separate investigation of this group will be subsequently undertaken. (JPRS)

9659 STRONG INTERACTIONS AND SYMMETRY. Komar, A. A. pp 341-63 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The symmetry properties of various types of elementary particle interactions are the object of increasing attention in elementary particle physics. The current situation in this field is such that the employment of the apparatus of higher symmetries for all classes of processes without exception (unless internal contradictions are involved, as in the U(6,6) group) limits the accuracy of predictions markedly, and often these predictions deviate markedly from experiment. A better understanding of the conditions for the applicability of a specific symmetry group requires a thorough analysis of the dynamics of the processes. Certain prospects in this direction are opened by the algebra of charges and possibly also by bootstrap-type formalism (a theory equating the existence of symmetries with the condition of harmony of the system of equations describing the mutual transformations of particles). In addition, the analysis of quark models of elementary particles remains a highly important research tool, since models of this kind make it feasible to find a fairly simple explanation for many consequences implied by the formal apparatus of higher symmetries as well as to deduce a number of other unexpected consequences. (JPRS)

9660 CONFLUENCE OF REGGE TRAJECTORIES AND SU(2)w'-SYMMETRY. Volkov, D. V. pp 408-13 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

An exemplary collinear symmetry group which occurs when the square of the transmitted momentum is near-zero and which is a consequence of the normal requirements for the analytical quality of matrix elements is discussed. The starting premise is that Regge poles in partial amplitudes of nucleon-antinucleon scattering when $t = 0$ (t is the square of the total energy of the nucleon and antinucleon) cease to be independent and simple integer-valued relations set in between their positions. The presence of these relations indicates some asymmetry in the scattering amplitudes when $t = 0$. This particular type of symmetry is derived, and is related to the collinear $SU(2)'_w$ group. Different variants of this group are examined. It is shown that the matrix elements for $t = 0$ can be represented by the mathematical product of the residual currents; this indicates that the pertinent group of transformations is related to the gradient transformations for fields of an arbitrary tensor form. (JPRS)

9661 GEOMETRIC DERIVATION OF MASS FORMULAS FOR THE SU(3) SYMMETRY. Kadyshevskii, V. G.; Stoyanov, D. Ts. pp 439-42 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Mass formulas in the SU(3) scheme can be derived by adding a perturbation with suitable tensor properties to the invariant mass operator. In this connection it is shown that formulas of this kind can be derived from an examination of certain special SU(3) transformations in the space of quark masses without resorting to any specific relations describing the mass operator associated with the perturbation theory and the hypothesis of the "octet" nature of moderately strong interactions. This is true if the operator remains diagonal with respect to the hypercharge and isotopic spin in the presence of moderately strong interactions with or without electromagnetic interactions. This is accomplished by disregarding the renormalization of the baryon wave functions, on the assumption that the coefficients with which these functions enter the concerned octet remain unaffected by interactions perturbing the SU(3) symmetry; clearly such an approximation corresponds to the first-order theory of perturbations. (JPRS)

9662 TWO-MESON ANNIHILATION OF ANTIPROTON AND HIGH SYMMETRIES. Winternitz, P.; Makarov, A. A.; Nguyen Van Hieu. pp 443-7 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The process of two-meson annihilation of an antiproton on a nucleon is noteworthy by virtue of the following considerations: The result of a large number of theoretical studies intended to achieve a relativistic generalization of the SU(6) group through finite-dimensional representations of the SL(6,C) or U(6,6) groups is the collinear subgroups $[SU(3) \otimes SU(3)]_{coll}$ and $SU(6)_w$. The method used represents a sequential method for the construction of matrix elements that are invariant with respect to these subgroups. Both groups give satisfactory predictions for vertices, but the findings on annihilation are a strong argument in favor of the $[SU(3) \otimes SU(3)]_{coll}$ group and against the $SU(6)_w$ group. (JPRS)

9663 QUARKS AND COMPOUND MODELS OF ELEMENTARY PARTICLES. Struminskii, B. V.; Tavkhelidze, A. N. pp 625-38 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The quark model of elementary particles, which assumes that all elementary particles are connected states of more fundamental particles, quarks, which are the carriers of all the principal properties of symmetry is discussed. Quarks and SU(3) and SU(6) groups play an important role in the theoretical group approach to the investigation of the symmetry properties of strongly interacting particles, through which some success has been achieved in the direction of compiling a "Mendeleev's table" for elementary particles. (JPRS)

9664 HADRON SYSTEMATICS BASED ON HIGH SYMMETRIES. Malyuta, Yu. M. pp 678-92 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The classification of strongly interacting particles within the framework of a shell model based on the $SU[3(2j + 1)]$ (jj-coupling) group is given. The fundamental particles in the model are quarks in an excited nlj-state. Meson supermultiplets belonging to the configurations $(1s\,1/2)^{-1}$, $(1s\,1/2)^1\,(1p\,1/2)^{-1}$, $(1p\,3/2)^1\,(1d\,3/2)^{-1}$ and $(1d\,5/2)^1\,(1d\,5/2)^{-1}$ are investigated, along with baryon supermultiplets belonging to the configurations $(1s\,1/2)^3$, $(1s\,1/2)^2\,(1p\,1/2)^1$, $(1p\,3/2)^3$ and $(1d\,5/2)^3$. Mesons and baryons with supermultiplet components are identified and a diagrammatic method is proposed for finding mass formulas which can be used to analyze the spectra of meson and baryon masses. (JPRS)

9665 REPRESENTATION MIXING IN $U_{6,6}$ AND ITS APPLICATION TO WEAK AND ELECTROMAGNETIC INTERACTIONS. II. Akyeampong, D. A. (Univ. of Ghana, Legon). Nuovo Cim. (10), 52A: 1102-11(Dec. 21, 1967).

The recent conjecture by Dashen and Gell-Mann that the low-lying baryon states may not belong to any pure representation but may be in a mixed representation is studied in the context of $U_{6,6}$ and various predictions, resulting from such a conjecture, are made and compared with experiment. It is found that an impressive agreement with experiment is obtained if the mixed representations (220, L = 1) and (364, L = 0) are chosen. (auth)

9666 SU_3 HARMONICS AS BASIS STATES FOR MESON RESONANCES. Nelson, T. J. (Ames Lab., Iowa). Contract W-7405-eng-82. Nuovo Cim. (10), 52A: 985-1003(Dec. 21, 1967). (IS-1511).

A mass eigenvalue problem is developed and solved using SU_3 harmonics as basis functions and the simplest operators having the transformation properties of the t = u = 0 component of an octet to break the symmetry. The mass operator contains three adjustable parameters and can be made to yield satisfactory fits to the masses of the $J^P = 1^-$ and 2^+ nonets, though with a somewhat unorthodox interpretation of the data in the latter case, where the problem is obscured by the large uncertainties in the experimental masses. In the former case, the masses are better known and the agreement is excellent. The approach offers no improvement, theoretically or numerically, over the standard mass formula for the 0^- mesons. (auth)

9667 DIFFICULTIES WITH NONLINEAR (e.g. CHIRAL) DYNAMICS. Fried, H. M. (Brown Univ., Providence). Nuovo Cim. (10), 52A: 1333-5(Dec. 21, 1967).

Comments are made on the fundamental difficulties encountered in chiral dynamics for calculations of low-energy pion and nucleon processes. Two examples are considered: a chiral model and a Gaussian model. (L.B.S.)

9668 SYMMETRY BREAKING IN THE STRONG-COUPLING LIMIT. North, Gerald Raymond. Madison, Wis., Univ. of Wisconsin, 1966. 80p.
Thesis.

The strong-coupling approximation is used to compare mass-shell methods with the Hamiltonian method for computing mass splitting of baryons due to various driving forces. The charge-symmetric-scalar model with static source is treated explicitly, and the results are compared to the Dashen–Frautschi (DF) theory of preferred tensor operators. By preferred tensor operators is meant that mass shifts transforming according to one representation are preferred over those transforming according to another due to bootstrap effects. Multichannel effects and crossing symmetry are treated exactly within the framework of the model. Graphical methods are presented for the manipulation of Clebsch–Gordon coefficients in the static model. The explicit forms of the many-channel N and D matrices are derived from Goebel's strong-coupling theory. A curious feature of the strong-coupling solution of the N/D equations is the appearance of CDD poles at infinity. The CDD poles play the role of elementary particles in the theory and therefore lead to ambiguities in the DF method. The ambiguities may be removed by using the Hamiltonian method to select the proper solutions of the DF equations. It is still found that several assumptions made in the DF treatment are invalid in the strong-coupling limit, and that in fact there are no preferred tensor operators in the symmetry breaking. The lack of preferred tensor operators can be traced to the fact that the scattering amplitude is not an explicit function of the masses but only a function of the renormalized coupling parameters. It is argued that strong coupling with its treatment of crossing and many-channel effects may be a better approximation to nature than the model employed by Dashen and Frautschi. (Disser. Abstr.)

Field Theories

General

Refer also to abstracts 9496, 9621, 9671, and 9672.

9669 IS THE SPECIAL THEORY RIGHT OR WRONG? Nature (London), 217: 17-18(Jan. 6, 1968).

In Nature 216: 119(1967) Professor H. Dingle argued that the special theory of relativity is incorrect, and Professor W. H. McCrea (loc. cit. 122) put an opposing view. Some correspondence on the same subject has already appeared. A further selection from the correspondence on this subject is given. (auth)

Quantum Field Theory

9670 (JINR-P2-3606) BESKONECHNYE MUL'TIPLETY V KVANTOVOI TEORII POLYA. (Infinite Multiplets in Quantum Field Theory). Dao Vong Dyc; Cao Chi; Nguyen van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 47p. (In Russian). Dep.

Some essential results in quantum field theory with infinite multiplets obtained previously are treated. The explicit expression of the matrix of finite Lorentz transformation is found. The interaction of infinite multiplets is studied and its specific properties are shown. The quantization of fields with infinite multiplets is considered and the existence of big free local fields with normal connection between spin and statistics is shown. The generalized Feyman rules are formulated. (auth)

9671 QUANTUM ELECTRODYNAMICS IN THE GENERAL COVARIANT GAUGE. Nakanishi, Noboru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 38: 881-91(Oct. 1967).

A manifestly covariant quantization of the electromagnetic field in the general covariant gauge is presented by extending the method of the quantization in the Landau gauge. In Feynman gauge, the theory presented reduces to the Gupta-Bleuler formalism. The Hamiltonian of the system is explicitly constructed, and it is pointed out that its free part is formally identical with the one proposed by Utiyama in his classical, generalized canonical dynamics. The unitarity of the physical S-matrix is also discussed. (auth)

9672 CANONICAL QUANTIZATION OF THE FREE ELECTROMAGNETIC FIELD IN THE LANDAU GAUGE. Goto, Tetsuo; Obara, Takashi (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 38: 871-80(Oct. 1967).

The canonical formalism of the electromagnetic field in the Landau gauge is studied. Unlike the case of Nakanishi, the dipole ghost states are not introduced. The singular character of the longitudinal and scalar components are pointed out, and the difficulty originated from the unnormalizable norm of the state vectors are evaded by an appropriate limiting procedure. The interacting case is also discussed in the interaction representation. (auth)

9673 CERTAIN NON-LOCAL MODEL OF FIELD INTERACTIONS AND ALGEBRA OF FIELD OPERATORS. Stavraki, G. L. pp 298-312 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The construction of a mathematical model in which the interrelation between quantized fields are compared with interactions in the neighborhood of a single point is described. It is shown that a complete construction of the model requires the solution to the problem of the classification of certain algebras, which has not yet been accomplished. Hence, in addition to formulating the principles for this construction, only a general discussion of the model is presented and preliminary mathematical findings are expounded. The model is based on a hypothesis for the nonlocal nature of field interactions. To formulate a distinctive "principle of correspondence" with the conventional theory as a means of transition from locally interacting quantized fields to the nonlocal model, a schematic example is considered from the standpoint of Lagrangian formalism of the conventional theory. It is assumed that at small distances, the conventional Lagrangian formalism incorrectly describes field interactions and may be replaced with relations of u universal algebra of field operators. An algebra of this kind is termed the K-algebra; it is supposed to describe real fields and interactions, and the assumption of existence of this algebra entails as a corollary the assumption of the existence in nature of fields whose quantum numbers, coincide with the quantum numbers of the corresponding operators of this algebra, as well as of interactions for which the coefficients of the corresponding trilinear Lagrangians represent the coefficients of the new algebra fairly accurately. (JPRS)

9674 THE YANG-MILLS FIELD. Faddeev, L. D. pp 766-9 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Excitation theory for the Yang-Mills field is considered giving special attention to the construction of a theory for a Yang-Mills field in which difficulties usually encountered in obtaining gradient invariance do not arise. (JPRS)

9675 NOTES ON PARA- AND SUPER-STATISTICS. Govorkov, A. B. pp 770-7 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

It is shown that a para-field is another form of notation of a fermion or boson field excited relative to some additional internal quantum number and has no relation to the generalization of identical particles, and that a scheme of superstatistics, in turn, does not satisfy the condition for the possible existence of the particles in an independent state. (JPRS)

9676 SPACE AND TIME LOCALIZATION OF RELATIVISTIC MICROPARTICLES. Blokhintsev, D. I. pp 778-90 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

It is noted that the literature on the problem of relativistic particle localization states that a spinor particle cannot be precisely localized because states with positive energy cannot form a complete system of functions. It is then shown that if quadratically integrable wave packets are considered instead of δ-functions the particles can be localized in states with positive energy to any degree of precision. (JPRS)

9677 SCHWINGER TERMS FROM LOCAL CURRENTS. Hellman, W. S.; Roman, P. (Boston Univ.). Nuovo Cim. (10), 52A: 1341-4(Dec. 21, 1967).

It is demonstrated that the appearance of Schwinger terms can be exhibited directly from local currents. For simplicity, a field theory with one space-like and one time-like dimension is examined; the realistic case for three space and one time dimension is then considered. It is noted that the result is perhaps indicative that the vacuum expectation value of products of spin-one-half currents is less singular than is usually assumed since the Schwinger terms were obtained without point-splitting. (L.B.S.)

9678 A NEW ASPECT OF THE CALCULATION OF QUASI-STATIONARY SOLUTIONS TO THE TIME-DEPENDENT SCHROEDINGER AND KLEIN–GORDON EQUATIONS. Almstrom, H. (Royal Inst. of Tech., Stockholm). Nuovo Cim. (10), 52A: 1313-20(Dec. 21, 1967).

A method is described for calculating the quasi-stationary solutions to the time-dependent Schroedinger and Klein–Gordon equations. Two examples are given where approximate solutions are obtained. (L.B.S.)

9679 WEAK LOCAL COMMUTATIVITY IN NONRENORMALIZABLE THEORIES. Khoruzhy, S. S. (Steklov Mathematical Inst., Moscow). Phys. Lett., 26B: 17-19(Dec. 11, 1967).

In the framework of an axiomatic nonrenormalizable theory of Wightman type two simple remarks concerning the property of the weak local commutativity are proved. (auth)

9680 SOME REMARKS ON THE GAUGE TRANSFORMATION AND THE SCHWINGER MODEL. Velo, G. (Univ., Bologna). Nuovo Cim. (10), 52A: 1028-37(Dec. 21, 1967).

Operator solutions for the Schwinger model are written. The definition of the current and its gauge transformation properties are discussed. (auth)

9681 FREE GHOST GAUGE FIELDS. Loos, H. G. (Douglas Advanced Research Labs., Huntington Beach, Calif. Univ. of California, Riverside). Nuovo Cim. (10), 52A: 1085-91 (Dec. 21, 1967).

Singularity-free non-Abelian solutions of the classical free Yang–Mills equations are shown to exist, which have a vanishing energy-momentum tensor density. Their internal holonomy group is found to be noncompact. (auth)

9682 QUANTUM ELECTRODYNAMICS WITH TWO FERMIONS. II. Kompaneets, A. S.; Kruzhkova, L. A. (Inst. of Chemical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 111-13(Aug. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 611-13(Aug. 15, 1967).

It was previously shown that in quantum electrodynamics with two fermions (electron and muon), diverging diagrams containing closed loops can cancel each other, making it possible to construct a theory free of infinite renormalizations. An attempt is made to modify the procedure in a way as to retain the main result, but avoid any contradiction to the general requirements of field theory. (L.B.S.)

9683 ANTISYMMETRIC FIELD QUANTIZATION AND FUNCTIONAL INTEGRATION. Klein, O. Z. Naturforsch., 22a: 1291-3(Sept. 1967). (In German).

From the Matthews and Salam treatment of the antisymmetric quantization of a Dirac field by means of functional integration using anticommuting field functions, it was shown that a method without descrepancies requires the comutability of the field function. (tr-auth)

9684 APPLICATION OF MATHEMATICS TO PROBLEMS IN THEORETICAL PHYSICS. Lurcat, F. (ed.). Cargese Lectures in Theoretical Physics. New York, Gordon and Breach Science Publishers, 1967. 514p. $17.50, Hardbound; $12.00, Paperbound.

The applications discussed include quantum field theory and group theory. Topics covered are the theory of local observables, operator algebras, quantum field theory on the Poincaré group, quantum statistical mechanics and canonical commutation relations, representations of canonical commutation relations, and integration in infinite-dimensional vectorial space. Also covered are Banach algebras and asymptotic mechanics, mathematical theory of nonrelativistic two- and three-particle systems with point interactions, and the algebraic approach to field theory. The group theory applications include representations of the noncompact unitary groups SU(p,1), classical properties of Lie groups, relations between internal symmetries and relativistic invariance, the SU(6) model of elementary particles, and current algebra applications. (J.F.P.)

9685 CASTILLEJO, DALITZ, AND DYSON POLES AND ASYMPTOTIC FIELDS. Jernow, Stanley Kenneth. University Park, Pa., Pennsylvania State Univ., 1966. 110p.

Thesis.

The meaning of Castillejo, Dalitz, and Dyson poles (C.D.D. poles) is examined from a field theoretic viewpoint. Two models (the Lee model and a boson separable potential model) were investigated. By studying the asymptotic field operators of these models it was found that C.D.D. poles have a profound influence: the operator algebra is radically changed in the presence of C.D.D. poles. With one pole it was discovered that, in order to bring the algebra back to its original form, an additional particle field must be added to each model. For the separable potential model this new particle was found to be unstable. Furthermore the original algebra of the fermion asymptotic field operators of the Lee model was discovered to be different from that of free particle operators. The anticommutators have the form $\{A_{i,\,in}, A^{\dagger}_{i,\,in}\}_{+} = 1 - \Sigma_{j\neq i} A^{\dagger}_{j,\,in} A_{j,\,in}$ where the sum is over all asymptotic fields. Anticommutation relations of this form will hold true for all fields which obey a general Pauli exclusion principle and are orthogonal to one another; these results are valid for boson as well as fermion fields. A further consequence of this research has been the development of a method for constructing Hamiltonians which, a priori, yield scattering amplitudes containing C.D.D. poles. (Disser. Abstr.)

Gravitation and General Relativity

9686 GRAVITATIONAL RADIATION FROM UNIFORMLY ACCELERATED PARTICLES IN GENERAL RELATIVITY. Bicak, J. (Charles Univ., Prague). Proc. Roy. Soc. (London), Ser. A, 302: 201-24(Jan. 2, 1968).

An exact solution of Einstein's vacuum equations representing uniformly accelerated particles was given by Bonnor & Swaminarayan. The radiative properties of this solution are here investigated by Bondi's method. After the introduction of the metric due to Bondi, the news function is found and the asymptotic behavior of the Riemann tensor is analyzed. The non-vanishing news function and the radiative character of the Riemann tensor at light infinity indicate that the solution is of radiative type; in particular, the solution is radiative in the case of freely gravitating masses. By comparing the solution of Bonnor & Swaminarayan with Born's solution in electrodynamics the results of Bondi's method are modified for the system which is not permanently isolated. The angular distribution of the radiated energy and the total rate of radiation of energy and momentum are found in the case of freely moving particles with sufficiently small masses. Gravitational radiation of these particles is very similar to electromagnetic radiation of an analogous system of charges. At the moment when the masses or the charges are at rest, the resulting expressions are corroborated on the basis of the approximation method of Bonnor & Rotenberg and of the standard multipole expansion method. The radiation has octupole character. In addition to outgoing radiation, incoming radiation with similar properties is present. This incoming radiation can exist in spite of the radiation condition; an additional condition which excludes the incoming radiation is suggested. (auth)

9687 ORIGINS OF SPACE–TIME AND INERTIA. Lynden-Bell, D. Mon. Notic. Roy. Astron. Soc., 135: 413-28(1967).

Mach's principle is incorporated into classical General Relativity by writing Einstein's equations as explicitly covariant integral equations involving retarded bi-tensor Green's functions. These Green's functions must be found for the Robertson–Walker metrics in order to discover which, if any, of those universes are Machian. In this theory all empty universes are non-Machian and the cosmical constant is zero. It is argued that in any truly Machian theory space-time itself must be caused by the matter, and in this theory it may be considered as propagating over itself out from the matter. Mach's principle may also be expressed as a boundary condition on the past singularities of the universe in a way that corresponds to the idea that all space-time, and therefore all inertial and gravitational influences, come from matter. (auth)

9688 POSITIVE DEFINITENESS OF GRAVITATIONAL FIELD ENERGY. Brill, D. (Yale Univ., New Haven); Deser, S. Phys. Rev. Lett., 20: 75-8(Jan. 8, 1968).

The total gravitational field energy functional is shown to have only one extremum under variation of the metric field variables. At the extremum the energy vanishes and space is flat; second variation shows that the vacuum state is also a local minimum. (auth)

9689 SCHIFF'S PROPOSED GYROSCOPE EXPERIMENT AS A TEST OF THE SCALAR-TENSOR THEORY OF GENERAL RELATIVITY. O'Connell, R. F. (Goddard Space Flight Center, New York). Phys. Rev. Lett., 20: 69-71(Jan. 8, 1968).

An explicit expression for the precession of a gyroscope in the Brans-Dicke scalar-tensor general relativity theory is compared with the results derived by Schiff using Einstein's theory, and it is suggested that the gyroscope experiment offers the best possibility for testing the Brans-Dicke theory. Further, it is concluded that the gyroscope in a satellite offers a more sensitive test than the earth-bound gyroscope. (auth)

9690 COVARIANT WAVE EQUATIONS FOR CHARGED PARTICLES OF HIGHER SPIN IN AN ARBITRARY GRAVITATIONAL FIELD. Cohen, H. A. (Univ. of Adelaide). Nuovo Cim. (10), 52A: 1242-53(Dec. 21, 1967).

It is known that special difficulties are encountered in devising a wave equation to describe higher spin $S \geq 3/2$ particles in interaction with the electromagnetic field, and Buchdahl has shown that like difficulties arise when the gravitational field is introduced. It is shown that just as a consistent electromagnetic interaction can be introduced, so wave equations describing charged particles of spin $S = 3/2$ and of spin $S = 2$ in a universe endowed with a Riemannian metric can be devised. An account of Dirac γ matrices in general relativity is incorporated. (auth)

9691 DEGENERATE SURFACE CUTS IN THE TOLMAN SOLUTION. PHYSICAL SINGULARITY IN GENERAL RELATIVITY. Papapetrou, A.; Hamoui, A. (Institut Henri Poincare, Paris). Ann. Inst. Henri Poincare, Sect. A, 6: 343-64(1967). (In French).

A definition is proposed of what should be considered as a physical singularity in general relativity. A special case of the Tolman solution for the gravitational field of a spherically symmetric distribution of dust-like matter (without pressure) is discussed in detail. The characteristic feature of this particular solution is that at a certain moment $t = T$ the totality of matter lies on a spherical surface $r = a \neq 0$. It follows that the density of matter and consequently also certain curvature invariants will be infinitely large, like the Dirac function $\delta(r - a)$, on the sphere $r = a$, $t = T$. In spite of this infinity there is no singularity on this sphere according to the definition proposed. It is shown in detail that from the given Tolman solution which is valid for $t < T$ it is possible to determine the motion of the material distribution as well as the gravitational field for $t \geq T$. The result shows that the equations of motion allow a certain weakening of the Lichnerowicz differentiability conditions on the metric tensor. (auth)

9692 NINTH PSEUDOSCALAR MESON IN BROKEN $SU_W(6)$ SYMMETRY. Zaslavskii, A. N.; Ogievetskii, V. I.; Tybor, V. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 106-7(Aug. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 604-6(Aug. 15, 1967).

The possible violations of the $SU_W(6)$ group are discussed. Two mass formulas for the mesons are obtained, from which the masses of the ninth pseudoscalar meson and the ρ meson are determined to be 1400 MeV and 790 MeV, respectively. It is noted that if experiments confirm the value 0^- for the E(1420) meson, then this meson should be regarded as the ninth pseudoscalar meson within the framework of $SU_W(6)$ and $SU_X(6)$. (L.B.S.)

9693 COVARIANT DECOMPOSITION OF SYMMETRIC TENSORS AND THE GRAVITATIONAL CAUCHY PROBLEM. Deser, Stanley (Institut Henri Poincare, Paris. Brandeis Univ., Waltham, Mass.). Ann. Inst. Henri Poincare, Sect. A, 7: 149-88(1967).

A search is made for a covariant equivalent of the decomposition, in a fixed frame, of a symmetric tensor into its irreducible parts which is essential to the reduction of the gravitational field to canonical Hamiltonian form. This search is motivated by the fact that, if one takes as field variables the Einstein tensor G_{ij}, of the three-space t = const. and the second fundamental form coefficients, the constraint equations are simply the requirements that these two tensors be covariantly transverse and that the trace of G_{ij} be fixed. The existence of such a covariant decomposition is demonstrated, and its properties exhibited. The latter enables one to characterize the general solutions of the constraint problem in a relatively explicit, though formal, fashion. These are then used to investigate the problem of positiveness of the field energy. The remaining, time-development, Einstein equations are also recast in terms of the present variables. Possible applications are discussed. (auth)

9694 SPHERICALLY SYMMETRIC NONSTATIC SOLUTIONS OF EINSTEIN'S EQUATIONS. McVittie, G. C.; Stabell, R. (Univ. of Illinois, Urbana). Ann. Inst. Henri Poincare, Sect. A, 7: 103-14(1967).

A group of metrics describing a spherically symmetric mass in radial motion is investigated. If the mass is at rest at the initial moment, it will collapse or expand according as the radial coordinate of the boundary, r_b, is greater or less than a limiting value, r_s. During the expansion or contraction of the mass, the density is a function of the time alone while the pressure is a function of the time and the radial coordinate. In the case of collapse no oscillatory motions are found; the mass collapses into a singular state of infinite density and pressure of zero volume. The internal metrics are fitted in a preliminary fashion to an external Schwarzschild metric. (auth)

9695 PROBLEM OF TWO- OR THREE-BODY MOTION IN GENERAL RELATIVITY. Mas, Luis. Ann. Inst. Henri Poincare, Sect. A, 7: 1-76(1967). (In French).

The two-body problem is treated starting from the variational equations of Einstein's equations, and in order to do so it is supposed that one of the two bodies has an inferior mass of an order depending on the other mass. The variation is calculated from the Schwarzschild metric. On the whole the calculations are restricted to the spherically symmetric case. The canonical formulation, in the general relativity, of the equations of motion corresponding to two or three bodies are considered. Starting from the already found Lagrangians and applying the method of constants variation, the advance and the retardation of the perihelion are calculated in the case of two bodies. (auth)

9696 OPERATIONAL IDENTIFICATION OF SCHWARZSCHILD CO-ORDINATES. Davidson, W. (Univ. of Otago, Dunedin, N. Z.). Nature (London), 216: 771-2(Nov. 25, 1967).

An operational interpretation of the standard Schwarzschild metric co-ordinates, r and t, is presented, together with a test of general relativity. This test employs the operationally defined co-ordinates L and T in place of r and t as the theoretical variables. The test requires the use of two spacecraft, each equipped with a radio pulse transmitter-receiver. (auth)

9697 GRAVITATIONAL ANALOGUES OF MAGNETIC MONOPOLES. Dowker, J. S.; Roche, J. A. (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 92: 1-8(Sept. 1967).

The analogy between gravitation and electromagnetic theory is discussed and used to obtain, for linearized gravitation theory, an analog of the magnetic monopole. This analog results in a quantization of mass. If a similar attempt is made to use the analogy between spin and charge it is found that Einstein's theory must be substantially modified to obtain an analogue of a magnetic monopole. (auth)

9698 MOTION OF STRETCHED OBJECTS IN THE EINSTEIN GRAVITATION THEORY. Beiglboeck, W. (Univ., Heidelberg). Z. Naturforsch., 22a: 1342-7(Sept. 1967). (In German).

For an expanding material body described with relativistic hydrodynamics, satisfactory conditions were given so that its inertia motion in the complete weak field of a (in the Einstein sense) gravitationally nontrivial world is rigidly geodetic. The present study is limited to special gravitational fields which are indirectly established by these conditions. (tr-auth)

9699 EINSTEIN FIELD EQUATIONS FOR THE AXIALLY SYMMETRIC, STATIONARY GRAVITATIONAL FIELD INSIDE A STRONGLY ROTATING IDEAL LIQUID. Truemper, Manfred (Univ., Hamburg). Z. Naturforsch., 22a: 1347-51(Sept. 1967). (In German).

The Einstein gravitational field equations for the interior of a strong and uniform rotating ideal liquid were derived and simplified. One of the field equations can be immediately integrated. The rest form a system of four quasilinear partial differential equations of the second order for four functions of two variables. (tr-auth)

Scattering Theory

9700 (NYO-2262TA-165) IMPACT PARAMETER DESCRIPTION OF HIGH-ENERGY SCATTERING. Islam, M. M. (Brown Univ., Providence, R. I. Dept. of Physics. Connecticut Univ., Storrs. Dept. of Physics). Sept. 1967. Contract AT(30-1)-2262. 92p. Dep. CFSTI.

The description of high-energy scattering of particles is emphasized. The formalism is considered including the eikonal approximation from the Klein–Gordon equation, the impact parameter representation of the elastic scattering amplitude, unitarity condition and the overlap function, the properties of the function a_1 (s,β), and the optical potential in the impact parameter description. The applications given are Coulomb scattering and bound states in the Coulomb potential, high-energy p + p scattering and hadronic structure of the proton, and high-energy behavior of diffraction peaks. (J.F.P.)

9701 (AERE-Trans-1066) GENERAL QUANTUM THEORY OF COLLISION PROCESSES. Brenig, W.; Haag, R. Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from Fortschr. Phys., 7: 183-242(1959). 72p. Dep. CFSTI. UK 10s. 0d.

A review is given of some more recent contributions of importance in this field. These contributions have included the concept of the S matrix. Main headings are as follows: Scattering theory; general collision processes; physical information given by S; resonance theory; behavior of S at low energies; analytical properties of S. 49 references. (UK)

9702 THE PROPERTIES OF THE CAUSAL S-MATRIX DECOMPOSITION IN BEAMS. Khodzhaev, L. Sh. (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSR, 173: 789-92(Apr. 1, 1967). (In Russian).

An attempt was made to find the space-similitude properties of S-matrix decomposition by groups of mean vacuum radiative operators and of the S-matrix elements within the limits of Bogolyubov axiomatic causal S-matrix theory. The decomposition properties of S matrix decomposition in groups were previously formulated and proven within the frame of the axiomatic quantum theory of Wightmann. A simplified case of self-action of one real scalar field was analyzed. Formulas obtained describe the decomposition properties of S matrix elements by groups. (R.V.J.)

9703 NONCOMPACT SYMMETRY GROUP AND UNITARY S MATRIX. Nguyen Van Hieu. pp 263-74 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

It is shown that to construct a theory of relativized SU(6) symmetry with a unitary S-matrix it is necessary to introduce a symmetry group G such that, on the one hand, it contains the homogeneous Lorentz group and the SU(6) group as its subgroups and, on the other, four-dimensional momenta of particles would form its irreducible representations. The structure of the unitary S-matrix is investigated from the standpoint of such symmetry. For a specific case, it is assumed that the S group is a U(6,6) group. A collinear compact subgroup of the S group is considered and the relation between this subgroup and the group $SU(6)_w$ (Lipkin, H., Meshkov, S., Phys. Rev. Lett., 1965, 14, 670) is investigated. The discussion pertains to an ideal case where the masses of all the particles in each infinite multiplet are identical. The theory considered involves the so-called S-matrix approach to the study of interactions. This raises the question of whether it is possible to construct a field-theory formulation of this symmetry, i.e., to describe the symmetry by the apparatus of the quantum field theory. (JPRS)

9704 RESTRICTIONS ON SCATTERING AMPLITUDES IN DISPERSION METHOD. Shirkov, D. V. pp 744-52 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The initial hypotheses formulated for the elements of S-matrices, on which the scattering matrix theory is based, and the selection of approximations which eliminate their contradictions in order to calculate such parameters of low-energy scattering as the position and width of the resonances and the scattering length are discussed. (JPRS)

9705 REDUCTION FORMULA, CURRENT, AND CURRENT-APPROXIMATION OPERATORS IN AXIOMATIC FIELD THEORY. Polivanov, M. K. pp 753-65 of Fizika Vysokikh Energii i Teoriya Elementarnykh Chastits. Shelest, V. P. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The principal concepts and apparatus of the dispersion approach in describing the dynamics of elementary interactions are defined, the equations of S-matrix theory are formulated and questions which arise in connection with current algebra in such an axiomatic theory are discussed. (JPRS)

9706 SELF-DAMPING MECHANISM FOR APPROXIMATE N/D EQUATIONS. Cornille, H. (Institute de Physique Nucleaire, Orsay, France). Nucl. Phys., B3: 655-70(1967).

Non-relativistic S-wave N/D equations are considered and the solutions corresponding to the left-hand cut discontinuity replaced by an arbitrary but finite number of poles are studied. In the space defined by the residues of the poles distinction is made between the interactions depending upon whether or not the corresponding states satisfy the usual spectrum requirements in the physical sheet. In this residues space, the self-damping domain of physically available interactions is a connected domain and the boundary is the internal Fredholm surface of the N/D equations when the normalization of D is 1 at infinity. (auth)

9707 DISCREPANCY BETWEEN THE MULTICHANNEL ND^{-1}-AMPLITUDE AND THE CORRESPONDING ONE-CHANNEL AMPLITUDE. Heiss, W. D. (Freie Univ., Berlin). Nuovo Cim. (10), 52A: 1201-8(Dec. 21, 1967).

The single-channel N and D functions are constructed from the known matrix N and D functions with their discontinuity given by the Frye–Warnock procedure. It is found that in the one-channel procedure additional parameters are necessary, if a zero of S_{11} has migrated through the inelastic cut onto the physical sheet. (auth)

9708 CONSTRUCTION OF POTENTIALS FROM GIVEN DYNAMICAL DISCONTINUITIES OF PARTIAL-WAVE AMPLITUDES. Dosch, H. G. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nuovo Cim. (10), 52A: 1092-1101(Dec. 21, 1967). (MIT-2098-297).

A method is derived, which allows the determination of a potential from given dynamical singularities of partial-wave amplitudes. The special examples of the one-pole approximation of the left-hand cut and the singlet nucleon–nucleon amplitudes are treated. (auth)

9709 REGGE-LIKE POLES IN THE IMPACT PARAMETER PLANE. Dean, N. W. (Cambridge Univ., Eng.). Nuovo Cim. (10), 52A: 1129-51(Dec. 21, 1967).

The transformation of an impact parameter representation of the high-energy scattering amplitude into a contour integral in the complex b^2-plane leads to the possibility of pole terms similar to Regge poles. In the crossed channel the behavior of these pole terms is consistent with the exponential smallness of large-angle scattering cross-sections. Using the Blanckenbecler–Goldberger representation as a starting point the pole term contributions of a variety of potentials are analysed. Both these poles and Regge poles are results of a general procedure applicable to parametric representations of the scattering amplitude. Connections between them are investigated, and the forms resulting from several other possible parametrizations are found. (auth)

9710 REGGE CUTS IMPLY VANISHING TOTAL CROSS SECTIONS OR ESSENTIALLY CONSTANT DIFFRACTION PEAKS. Gervais, J.-L.; Yndurain, F. J. (New York Univ., N. Y.). Phys. Rev. Lett., 20: 27-9(Jan. 1, 1968).

It is shown that the infinite sequence of Regge cuts previously found in perturbation theory leads to high-energy behavior of scattering amplitudes with a power of the energy that is independent of the momentum transfer whenever the total cross sections are asymptotically constant. (auth)

9711 K MATRIX AND REGGE POLES. Starikov, V. N. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 67-75 (July-Aug. 1967). (In Russian).

The simple case of the scattering of pions by means of ρ meson exchange was studied in the framework of the K matrix and Regge poles. The trajectory of Regge Poles in the physical range of the s-channel was considered. In the multichannel case at high energy the K matrix can be expressed by Q_l functions. The contribution of poles, leaving clockwise at high energy, was found in complete cross section. The asymptotic behavior at high energy was investigated. (J.S.R.)

9712 MOMENTUM EIGENVALUE EQUATION FOR INTERACTING SYSTEMS. Anderson, J. T. (Naval Ordance Lab., Corona, Calif.). Nuovo Cim. (10), 52B: 375-8(Dec. 11, 1967).

An eigenvalue equation for the excitation momenta of an interacting system is obtained in first-order perturbation theory from self-consistent equations of motion for the particles and the field. The result is a form of the Cauchy-Riemann equations and provides a necessary condition for analyticity on the momentum plane. (auth)

Particle Accelerators

Refer also to abstracts 8364, 8392, 8848, 9117, 9489, 9497, and 9541.

9713 (CERN-67-24(Vol.4)) PROCEEDINGS OF THE 1967 CERN SCHOOL OF PHYSICS, RAETTVIK, MAY 21-JUNE 3, 1967. (European Organization for Nuclear Research, Geneva (Switzerland)). Nov. 10, 1967. 73p. Dep.

There were three lectures included. A separate abstract was prepared for each lecture. (J.F.P.)

For abstracts of individual lectures see: 9555, 9714, and 9715.

9714 (CERN-67-24(Vol.4), Paper 1) BEAM OPTICS. Steffen, K. G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). 14p.

A concentrated survey of concepts and methods in high-energy beam optics is given. Trajectory optics, magnet requirements for precision optics, composite spectrometers, envelope optics, and the fundamentals of beam shaping systems are covered. (J.F.P.)

9715 (CERN-67-24(Vol.4), Paper 3) POLARIZED TARGETS IN PARTICLE PHYSICS. Jacob, Maurice (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 15p.

By means of a few examples spin effects are shown in the theoretical analysis of the considered reactions. It is also shown how polarized targets may provide necessary information. The topics discussed are a definition and determination of spin amplitudes, meson (π)--nucleon scattering, and polarized targets and time reversal invariance. (J.F.P.)

9716 (JINR-P9-3552) OSHIBKI YUSTIROVKI V ELEMENTAKH IONO-OPTICHESKOI SISTEMY I IKH VLIYANIE NA URAVNENIE DVIZHENIYA CHASTITSY. (Adjustment Errors in the Ion-Optical System Units and Their Effect on the Particle Motion Equation). Bazhenova, I. M.; Zinov'ev, L. P.; Fedorova, R. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1967. 16p. (In Russian). Dep.

The equations of particle motion through the arbitrary ion-optical system are derived taking into account the effect of the main errors of this device. On the basis of the equations obtained the ratio is given, which determines the transformations of the exit beam, which are due to these errors. General theory is proved by private problems and by a practical example of calculation of a new system of injection into the synchrophasotron. (auth)

9717 (JINR-P9-3567) O SOGLASOVANII REZONATORA MIKROTRONA S VOLNOVODNYM TRAKTOM. (On the Matching of the Microtron Resonator With the Waveguide). Matora, I. M.; Khar'yuzov, R. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 18p. (In Russian). Dep.

The problem of matching between the microtron waveguide and the resonator at different loading electron beam powers is studied. The formulas connecting the standing wave coefficient in the waveguide and the resonator load are given. The theory well agrees with experiment. It is shown that, from the point of view of the acceleration process stability, the connection between the resonator and the waveguide is preferred to be more than the critical one. (auth)

9718 (JINR-P16-3591) PRIBLIZHENNYI METOD RASCHETA ZASHCHITY OT RASSEYANNOGO IZLUCHENIYA UCKORITELEI. (An Approximate Method of Calculation of Shielding from the Accelerator Stray Radiation). Zaitsev, L. N.; Kimel', L. R.; Komochkov, M. M.; Sidorin, V. P.; Sychev, B. S.; Ulitin, O. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 16p. (In Russian). Dep.

An approximate method of calculation of shielding from the accelerator stray radiation of different energy groups is given. The contributions to the dose rate from the stray radiation depending on the shielding thickness, made of an ordinary concrete containing 0.35 wt % of hydrogen are determined. The components of the total dose rate from soft and hard spectra of stray radiation at the JINR synchrocyclotron hall are calculated. (auth)

9719 (ORNL-4175) DESIGN CONSIDERATIONS FOR A SEPARATED-TURN ISOCHRONOUS CYCLOTRON (STIC). Gordon, M. M. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The separated-turn isochronous cyclotron (STIC) under study is a machine that should produce proton currents in the 50- to 100-mA range at energies from 200 to 1000 MeV with clear turn separation so that 100% beam extraction is achieved. Each stage of the cyclotron consists of a ring of identical magnet sectors interspersed with an appropriate set of rf acceleration cavities. The beam is injected from a linac, thereby eliminating the central-region problems associated with present isochronous cyclotrons. As a result of the narrow magnet gaps, the machine has relatively strong axial focusing throughout. The orbital frequency is high enough so that the beam can be accommodated within the space-charge limits. Additional small third-harmonic cavities provide for a flat top on the resultant voltage wave form, thereby allowing a relatively large phase width in the accelerated beam. Conditions for achieving clear turn separation are analyzed and found feasible. For a reasonable total number of turns, the isochronous field trimming requirements are quite tractable. Tentative design figures are presented and compared with the present separated-orbit cyclotron (SOC) designs. (auth)

9720 (UCID-15235) OBSERVATIONS ON SCATTERED-NEUTRON EFFECTS IN THE LRL VAN DE GRAAFF PIT. Nagle, R.; Landrum, J.; Lindner, M. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 1, 1967. Contract W-7405-eng-48. 6p. Dep. CFSTI.

The effect of scattered neutrons from the massive concrete shielding in the Van de Graaff and ICT pit at LRL in inducing background activation of gold foils has been studied in detail. Gold foils were shielded with gold, with cadmium, and with a combination of gold and cadmium foils. The quality of the results was judged by the adherence of the corrected activation to the inverse-square law with p-T neutrons from the LRL Van de Graaff machine. It was found that even the gold-cadmium combination shield did not remove all extraneous activation, and that a background activation had to be determined and applied to foils at all distances from the neutron source. (auth)

9721 (UJV-1854) MAGNETIC FIELD FOR ELLIPTICAL ION TRAJECTORIES. Hrda, A.; Krivanek, M.; Kuzmiak, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Aug. 1967. 8p. Dep.

An expression is derived for the distribution of the induction of a magnetic field in which the ion trajectories are concentric ellipses with identical semi-minor axes. The spatial distribution of the field in the central plane has been calculated numerically and is shown in graphical representation. The possibility of increasing further the energy of charged particles through multiple application of two tandem accelerators is mentioned. (auth)

9722 (AD-660393) DEVICE FOR SYNCHRONIZATION IN ACCORDANCE WITH THE ENERGY OF THE MOMENT OF INJECTION OF CHARGED PARTICLES INTO AN ACCELERATOR. Naumov, A. A.; Pil'skii, V. N.; Yudin, L. I. Translated by E. Harter from Russian Patent 175,153. 5p. (FTD-HT-23-542-67). CFSTI.

A device is described for synchronization in accordance with the energy of the moment of injection of charged particles into an accelerator with the aid of 2 triggering pulses which control the switching in of an electron gun of an injector and other devices assuring the capturing of the particles in the acceleration which contains pickups of the magnetic field and the voltage of the injector which has the distinguishing feature that for the purpose of creating the optimum conditions for seizure of the particles in the acceleration with equality to zero of the ratio $E - 300H_q$. A generator of calibrated pulses is connected with a summator the other inputs of which are connected with pickups and the output connected across the indicator of zero to a shaping device which serves for developing the triggering pulse at the moment of indication of zero. (tr-auth)

9723 (AD-660737) INJECTOR-TYPE ELECTRON ACCELERATOR WITH CONSTANT WAVE PHASE VELOCITY. Vishnyakov, V. A.; Grishaev, I. A.; Zykov, A. I.; Ostrovskii, E. K. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated from pp 1-12 of Inzhektornyy Uskoritel' Elektronov s Postoyannoy Fazovoy Skorost'yu Volny, No. 1, 1963. 11p. (FTD-HT-67-1). CFSTI.

It follows from the diagrams given that in operation at optimum frequency, the injector accelerator with constant wave phase velocity delivers the following accelerated-beam parameters: average current-10 μa (120 ma in pulse), particle energy-6.5 MeV, energy scatter-8%, beam radius-3mm, beam divergence-10^{-3} radian, and phase width of bunch-20 to 30°. It should be noted that in operation at optimum accelerator frequency, the dependence of the accelerated-beam parameters on the entry parameters, such as initial particle energy, accelerating-field strength, and generator frequency becomes weaker, and this improves the operating stability of the accelerator as a whole. The injector linear electron accelerator with constant wave phase velocity is quite competitive with waveguide bunchers in which the phase velocity of the wave varies. (auth)

9724 (ANL-Trans-535) RESEARCH REPORT OF THE UNILAC TEAM FOR 1964–1966. (Heidelberg Univ. (West Germany). Institut fuer Angewandte Physik). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report UNILAC-3-67. 90p. Dep. CFSTI. JCL $8.60 fs, $3.02 mf.

A review of the research done on the UNIVAC linear accelerator from 1964 through 1966 is presented. Ion source studies, charge-exchange experiments, development of the hf system, focusing and beam guidance studies, and injector systems are discussed. (W.H.K.)

9725 (LB/G-2577) ELECTROLYTIC TROUGH MEASUREMENTS CONCERNING THE ELECTROSTATIC FIELD OF PRESSURISED VAN DE GRAAFF GENERATORS. Kiss, A.; Koltay, E.; Szalay, S. Translated by G. R. Kiss (Atomic Energy Research Establishment, Harwell, Eng.), from Atomki (At. Kut. Intez.) Kozlem., 8: 101-14(1966). 26p. Dep. CFSTI. UK. JCL $2.60 fs, $0.98 mf.

In order to obtain nearly ideal electrode configurations for pressurized Van de Graaff generators, model measurements were carried out using the electrolytic trough method. As a result of these investigations a new electrode system is proposed which consists of a high voltage terminal shaped as a third-order paraboloid of rotation matching to a spherical calotte, and equipotential rings of oval section. In such a system the electrical stress is nearly uniform on the electrode surfaces. The field strength remains everywhere under the value obtained by linear extrapolation along the column to the position of the first equipotential ring. (auth)

9726 (UCRL-Trans-1360) INDICATION OF ELECTRON BEAM BY LIGHT OF BACKGROUND GAS. Bikmatov, R. G.; Boriskin, A. G.; Kudelainen, V. I.; Meshkov, I. N.; Parkhomchuk, V. V. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated for Univ. of California Lawrence Radiation Lab., Berkeley, from Russian report. 24p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The experiments of the registration of the residual gas light induced by the rectilinear electron beam (35 keV) and the betatron circular beam (3 MeV) are described. The output current of the recording photomultiplier, counted per unit of beam length and current, was equal to 1.2 ± 0.2 mA/A cm for rectilinear beam (the vacuum was of an order 10^{-4} torr. The light collection efficiency was equal to 6.5×10^{-4}) and was about 2 μA for circular one (the vacuum was of the order $6 \cdot 10^{-6}$ torr; the light collection efficiency was equal to 1.4×10^{-4}). (auth)

9727 DEVELOPMENT AND USES OF TOMSK POLYTECHNIC INSTITUTE ACCELERATORS. Chuchalin, I. P. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 83-92(1967). (In Russian).

A brief review is given of the design, construction and performance of electron accelerators developed in the Tomsk Polytechnic Inst. A list of types of betatrons constructed, their capacity, characteristics, years of operation, and location is included. Parameters are given also, for two types of microtron injectors for the 1.5 GeV synchrotron and strong-current, high-voltage accelerator. 52 references. (R.V.J.)

9728 COLD WAY TO FAST ELECTRONS. Firth, Ian (St. Andrews Univ., Scotland). New Sci., 36: 663-6(Dec. 14, 1967).

The exciting very-low-temperature effects have so far found few practical uses. The case is presented for exploiting superconductivity superfluidity in cryogenic linear electron accelerators. (auth)

9729 BREMSSTRAHLUNG DISTRIBUTION AT A VAN DE GRAAFF ACCELERATOR FOR POSITIVE IONS. Nachtigall, D. (Zentralbuero fuer Kernmessungen, Geel, Belg.). Kerntechnik, 9: 471-5(Oct. 1967). (In German).

Theoretical and experimental results are outlined which indicate that in the electron energy region below several MeV in target materials with atomic number $Z < 30$ the bremsstrahlung yield is less than 10%. The mean energy flux density is proportional to Z. The quantum flux density ratios between 0 and 90° have values, according to the target material and the electron energy, up to 40. The bremsstrahlung distribution of the 3-MeV Van de Graaff accelerator at Geel, Belgium, was measured. The results are shown graphically. (J.S.R.)

9730 DOSIMETRY AT HIGH-ENERGY ACCELERATORS. Freytag, E. (DESY, Hamburg). Kerntechnik, 9: 454-8(Oct. 1967). (In German).

Tolerance flux densities of various particles and the dose output equivalence of these particles are reviewed. The conditions at an electron accelerator are outlined in order to obtain an expression of the significance of the individual particles in dosimetry at high energy accelerators. The methods of dose equivalence measurements are given. (J.S.R.)

9731 NUCLEAR EVENTS AT 300 GeV. Nucleus (Paris), 8: 451-6(1967). (In French).

The fundamentals of the 300-GeV European proton synchrotron project are given. The importance and development of high-energy physics, the role of 300-GeV accelerator in European research and education, and the world-wide effort in high-energy physics are covered. (J.F.P.)

9732 DEVELOPMENT OF ACCELERATING SYSTEMS OF SYNCHROTRONS AT TOMSK POLYTECHNIC INSTITUTE. Vorob'ev, A. A.; Didenko, A. N.; Solntsev, B. A. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 157-60(1967). (In Russian).

Work on the development of accelerating systems at Tomsk Polytechnic Institute is divided into three groups. Accelerating systems for synchrotrons at energies from 10 MeV to 200–300 MeV constitute the first group. A system of ring electrodes which accelerate electrons by potential difference is employed. The shunt resistance of the ring electrodes can be kept high by connecting each pair as a load for the tuned two-conductor line. Although simple in construction, this system has the disadvantage of having a reverse field, which can be reduced by increasing the width of the rings. The second group involves accelerating systems for synchrotrons with energies above 1000 MeV. Because of the space and high voltage requirements, spherical or cylindrical resonators could not be used and toroidal-type resonators were developed. Two such 120-kV resonators in the gap with a resonator shunt resistance of 120 K-ohm at a frequency of 36.5 mC consume a power of 120 kW. Special measures had to be taken to eliminate high-frequency resonant discharge. The advantages of accelerated systems based on closed wave guides built into the accelerating chamber are discussed. It is stated that for high-energy synchrotrons they assure high efficiency and beam stability. Accelerating systems for synchrophasotrons are discussed in the third group. An accelerating voltage frequency variation during the cycle is typical for them, and their bandpass width must exceed this frequency variation range. In a NIIYaF TPI 300-MeV synchrophasotron, the frequency changes from 28 to 37.5 mC during the first 100 to 200 μsec. To assure such a bandwidth, the Q of the resonator must stay under 3. To preserve the efficiency of the system, two channels were employed during the cycle. A wide bandpass channel after the first 300 μsec of operation was replaced by a narrow bandpass channel for the rest of the cycle. (ATD)

9733 THE 300-GeV EUROPEAN ACCELERATOR PROJECT. Rev. Quest. Sci., 28: 248-53(Apr. 1967). (In French).

Reasons for the selection of 300-GeV as the energy of the accelerator include a balance between the importance of subnuclear physics, plans in other countries, complexity, costs, and delays. Provisional specifications for dimensions and power are listed; power consumption will approach 300 MW. Eight to 10 years will be required for construction, and laboratory personnel will total 4500. Diameter is 2400 m; location requirements are outlined, including dimensions of the site, stability of the foundation, availability of primary disposable equipment, location with respect to transportation and industry, and consideration of the preferences of the specialized personnel. Each member state was asked to preselect sites to reduce the number of proposed sites. Appropriate budgetary decisions by CERN are cited. The sites remaining for consideration in June 1966 were Goepfritz, Austria; Focant, Belgium; El Escorial, Spain; Le Luc, France; Aspropyrgos, Greece; Doberdo and Nardo, Italy; Drensteinfurt, Ebersberger Forst, and Neuforweiler, Germany; Mundford, Great Britain; and Uppsala, Sweden. A decision should be made by the end of 1967 so that work can begin in 1969. (BBB)

9734 THE 6 GeV ELECTRON SYNCHROTRON. Kuz'micheva, G. At. Energ. (USSR), 23: 463-5(Nov. 1967). (In Russian).

The design and construction of a 6-GeV electron synchrotron with a 50-MeV linear accelerator as an injector is presented. Some of the design parameters are: maximum energy–6 GeV, particles/pulse–10^{11}, pulses/sec–50, current–22 mA, mean radius of synchrotron–34.49 m, injection energy–50 MeV, output injector current–0.2A, energy dispersion at injector exit–±1.5%, and electromagnet weight–400 tons. (R.V.J.)

9735 THE 70 GeV PROTON SYNCHROTRON. Kuz'micheva, G. At. Energ. (USSR), 23: 461-3(Nov. 1967). (In Russian).

Descriptions are given of a strong-focusing 70-GeV proton synchrotron designed for operation in 1968. In addition to the protons the accelerator is capable of producing intense beams of secondary particles generated by the interactions of protons with targets: mesons ($\pi^{\pm}$) with energies of 60 GeV and mesons (K) and antiprotons with energies up to 40 to 50 GeV. The accelerator electromagnet weighing 20,000 tons was distributed in a 500 m diameter tunnel. The maximum feeding of the electromagnet is 100,000 kV. Tests carried out on Oct. 14, 1967 produced a 76 GeV proton beam. (R.V.J.)

9736 RADIOGRAPHY WITH 5-MeV LINEAR ACCELERATOR. Matsuyama, Itaru; Fujisawa, Masanao (Tokyo Metropolitan Industrial Research Inst.). Tokyo-to Kogyo Shoreikan Hokoku, No 18, 61-6(1967). (In Japanese).

This report describes fundamental data for radiography with a 5-MeV linear accelerator in the range 200 to 450 mm steel thickness. Results obtained are as follows. Penetrometer sensitivity is about 1% for 200 to 450 mm steel thickness. The best results of penetrometer sensitivity are obtained in the film density range 1.5 to 3.5. Fluoro-metallic intensifying screens (SMP301 or special) are effective screens for such thick specimens. By using these screens it was found that the exposure time was reduced by about half compared to the time required by lead screens used, and appearance of penetrometer wires on the radiographs with SMP screens used was better than with lead screens used. (auth)

9737 THE UNIVERSITY OF TORONTO LINEAR ACCELERATOR. McNeill, K. G.; Horrigan, E. W. (Univ. of Toronto). Nucl. Energy, 154-6(Nov.-Dec. 1967).

The accelerator which is briefly described is designed to give electrons of up to 30 MeV for nuclear and biophysical research. Operational safety features are outlined. (UK)

9738 CALCULATION OF THE ACCELERATION OF ELECTRONS TO 30 MeV IN A MICROTRON WITH RECTANGULAR RESONATORS. Matora, I. M.; Merkulov, L. A.; Shelontsev, I. I. Zh. Tekh. Fiz., 37: 1660-70(Sept. 1967). (In Russian).

Orbits of electrons being accelerated in the microtron of the Neutron Physics Laboratory of the Joint Institute for Nuclear Research have been calculated with a computer. The method by which these calculations were performed is described briefly and some of the results are presented and discussed at some length. The calculations were performed for rectangular microtron resonators of different shapes excited in the E_{101} mode with the accelerator operating in the second regime. The electron orbits were followed for 30 revolutions. Among the matters discussed on the basis of the numerical solutions are the region of accepted phases for different electric field strengths in the cavity, the intensity of the beam on different orbits, the effect of the size and location of the cathode, the drift of the center of curvature of the orbit due to the microwave magnetic field in the cavity, and phase oscillations. With a rectangular resonator designed on the basis of these calculations there were obtained stable 60-mA pulses of 30-MeV electrons. (ATD)

9739 DEPOLARIZATION OF A PROTON BEAM ACCELERATED IN A SYNCHROCYCLOTRON. Besnier, Gilbert (Univ., Rennes, France). Compt. Rend., Ser. A and B, 265: 456-9(Aug. 21, 1967). (In French).

The passage of a completely polarized beam by an ideal resonance is studied. It is assumed that the number of particles present in the beam is large. Under these conditions an attempt is made to find the results of the quantum analysis of this problem beginning with the classical equation of evolution of the microscopic Ma spin moment. (tr-auth)

9740 POLARIZATION OF SYNCHROTRON RADIATION. Mychelkin, E. G. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 83-9(July-Aug. 1967). (In Russian).

Those characteristics of the polarization of magnetobraking (synchrotron) radiation are indicated which were described by elementary functions and were uniformly applicable (with neglect of the radiation reaction and quantum correction) to all ranges of measurement of relativistic particle energy. (tr-auth)

9741 DEVICE FOR PRODUCING A PULSED CHARGED-PARTICLE BEAM. Tsuchimoto, Hisashi (to Hitachi Ltd.). Japanese Patent 1967-5311. Mar. 3, 1967. Filed May 10, 1965.

A method is proposed for obtaining a pulsed charged-particle beam of short pulse width from a duoplasmatron; the beam is used, in association with a charged-particle accelerator, or in other means. (TSS) (NSA of Japan)

9742 CHARGED-PARTICLE SOURCE, USING A PLASMA. Munakata, Chusuke (to Hitachi Ltd.). Japanese Patent 1966-1037. Jan. 22, 1966. Filed Oct. 24, 1964.

In the charged-particle source proposed, a neutral plasma is first produced, from which electrons or ions are extracted. It consists of the following: a discharge tube, having two discharge electrodes; a device for introducing a low-pressure gas into the discharge tube; a pulsed-current source for producing a discharge between the two electrodes; a device for applying a magnetic field in the direction perpendicular to the axis of the discharge; a shock tube through which the plasma produced by the discharge is accelerated by the magnetic field; and a device for drawing out positive or negative charged-particles from the accelerated, thus ejected, high-density plasma. (NSA of Japan)

9743 PARTICLE ACCELERATOR, INCLUDING THE BETATRON. Suzuki, Tetsu (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-16920. Sept. 26, 1966. Filed Feb. 26, 1965.

A particle accelerator is described where the wave form of the pulsed voltage applied to the electron gun is shaped, thereby improving the electron-injection efficiency. The system includes an electron gun; a device for applying a pulsed voltage to the electron gun; and a device for shaping the wave form of the pulsed voltage which employs either variable inductances, or variable condensers, or both. (NSA of Japan)

9744 HIGH VOLTAGE GENERATOR. Anahara, Ryoji (to Fuji Electric Mfg. Co., Ltd.). Japanese Patent 1966-17301. Aug. 11, 1966. Filed Aug. 22, 1964.

An improved high-voltage generator, specifically an improved multistage cascade rectifying circuit requiring a high-voltage input (e.g., Cockcroft—Walton's apparatus) is described. It usually requires an extremely large distance of earth insulation and hence a large space to install a high voltage, e.g., 3000 kV, generator in the atmosphere. Therefore, the generator is presently placed in a tank filled with a highly-insulating gas like SF_6. In this connection, improvements are done in the proposed high-voltage generator, including ease in maintenance and compactness of the generator itself. (NSA of Japan)

9745 ACCELERATING CAVITY-BODY FOR A LINEAR ION ACCELERATOR. Nagai, Akio (to Mitsubishi Electric Mfg. Co.). Japanese Patent 1967-5318. Mar. 3, 1967. Filed Apr. 28, 1965.

In the accelerating cavity-body proposed, an improved exit for evacuating the cavity body is employed whereby the deformation of an electromagnetic field due to its existence can be minimized. It is simple in construction and easy to construct. The evacuating exit (hole) is covered with a metal net or a plate having many small holes. (NSA of Japan)

9746 CHARGED-PARTICLE ACCELERATING DEVICE. Adachi, Takeshi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-5312. Mar. 3, 1967. Filed Sept. 15, 1965.

A charged-particle accelerating device is described whereby the potential gradient is made uniform with respect to the series of accelerating electrodes, and the occurrence of electric discharges immediately after application of the accelerating voltages is prevented. Thus, in the acceleration at high voltages of a large ion beam the accelerating device can be operated with high stability for longer periods of time. It consists of an insulating cylinder; two end plates which close the cylinder air-tight; a vacuum chamber provided by the closed cylinder; a device for evacuating the vacuum chamber; an accelerating tube connected to an ion source installed in the vacuum chamber; a plurality of conducting rings installed in contact with the inner surface of the wall of the vacuum chamber which selectively connect to the accelerating electrodes; and a plurality of conducting rings installed in contact with the ouside of the insulating cylinder. (NSA of Japan)

9747 TARGET WITH ITS COOLING DEVICE. Fujinaga, Atsushi; Yangisawa, Takeshi (to Mitsubishi Electric Mfg. Co.). Japanese Patent 1967-5315. Mar. 3, 1967. Filed Aug. 3, 1965.

A method is presented whereby the target in particle accelerators can be cooled very effectively in simple construction without using an electric motor. In the evacuated space in the extension of an accelerating tube is located the target. With this target-plate as one end-plate is produced a chamber. A pipe extends outward from the middle of the other end plate. On the inner face of the target plate are fixed blades. The chamber is rotatable, with the pipe (which penetrates the end plate of the evacuated space) as its axis. A pipe of smaller diameter runs through this pipe, entering the chamber space. Cooling water is introduced through the "smaller-diameter" pipe into the chamber; the jetted water dashes against the target plate with the blades, thereby turning round the chamber itself. Then the water leaves the chamber through the space between the chamber pipe and the smaller-diameter pipe. The accelerated particles impinge upon the target at the position some distance from the center of the target. (NSA of Japan)

9748 ION SOURCE FOR A PARTICLE ACCELERATOR. Ogawa, Kazuyuki; Kawasaki, Shinsuke (to Tokyo Shibaura Electric Co., Ltd). Japanese Patent 1967-5316. Mar. 3, 1967. Filed Sept. 24, 1965.

An ion source is described where the drop in the voltage of the anode is prevented and the heat release increased thereby stabilizing the beam current. It consists of a quartz tube forming an air-tight vessel; a plate of a metal such as molybdenum whose expansion coefficient is nearly the same as that of the quartz tube installed air-tight at one end of the quartz tube; the anode of a material such as alminum whose spattering is slight, fixed through the metal plate; a heat radiator, thermally connected to the anode, for removing heat of the anode outside of the quartz tube; a partitioning wall for preventing the secondary-electron bombardment within the vessel; and a cathode fixed in the quartz tube. (NSA of Japan)

9749 SUPERVISORY DEVICE FOR THE ION SOURCE OF AN ACCELERATOR. Ogawa, Kazuyuki; Kawasaki, Shinsuke (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-5320. Mar. 3, 1967. Filed Aug. 18, 1965.

A supervisory device for an ion source is described whereby the Balmer-series Hα bright-line of hydrogen is selectively detected by the use of photoelectric elements to supervise the behavior of the ion source. It includes an ion source installed at the end of a particle accelerator; a power source for exciting the ion source; an optical filter through which passes the Balmer-series Hα line-spectrum of hydrogen (out of the ion-source emission); the photoelectric-conversion elements which operate through the optical filter; and an indicator which indicates the electrical output of the photoelectric elements. (NSA of Japan)

9750 ELECTRON GUN WITH A PLURALITY OF THE CONTROL ELECTRODES. Kanaya, Koichi; Kawakatsu, Kyuzo (to Chief of the Agency of Ind. Sci. and Tech.). Japanese Patent 1967-5840. Mar. 9, 1967. Filed Sept. 10, 1963.

An electron gun is proposed in which the opposite effects in a triode electron gun, i.e., increasing the emitted electron current and focusing the current, are ingeniously compromised by means of the compound effect of a plurality of control electrodes in order to give a high-density electron beam. It consists of a cathode, an anode, and a plurality of the control electrodes. The cathode is located among the plurality of control electrodes. A negative potential is applied to the control electrode(s) behind the anode. The control electrode(s) in front of it has an orifice of a diameter sufficiently large for focusing the electrons outside the beam axis, and a positive, or negative, or zero potential is applied to the control electrode(s) according to the relative distances among the different electrodes. By this compound effect of a plurality of the control electrodes, a high-density electron beam which involves a high-order spherical aberration is obtained. (NSA of Japan)

9751 CHARGED-PARTICLE ACCELERATING TUBE. Maekawa, Akitsugu (to Hitachi Ltd.). Japanese Patent 1966-20239. Sept. 24, 1966. Filed Jan. 27, 1964.

In the proposed charged-particle accelerating tube, high energy-outputs are obtained by the high-frequency drive waves of $^2/_3\,\pi$ mode. For a given length of the accelerating tube, the energy output can be increased, or for the given energy output, the length of the tube can be decreased, in comparison with the conventional methods. The accelerating tube includes disc electrodes with a central hole and short cylindrical bodies connected alternately to one another. The ratio of the diameter 2a of the central holes to the free-space wavelength λ is made $0.14 \sim 0.18$. (NSA of Japan)

9752 BETATRON ACCELERATING TUBE WITH AN ELECTRON GUN OF TWIN FILAMENTS. Kanamori, Koji (to Shimadzu Seisakusho Ltd.). Japanese Patent 1966-20240. Sept. 24, 1966. Filed June 20, 1964.

A single electron gun having two filaments employed in the betatron accelerating tube is described. Thus, when one filament is broken during the betatron operation, the other filament can be started by means of a switch on the primary side of the pulse transformer. Thus, two filaments are installed in an electron gun. The one end of the two filaments are connected, in combination, to its respective point on the divided, secondary winding of the pulse transformer. The other end of one filament connects to the other end of its secondary winding; that of the other filament connects to the other end of its secondary winding. In consequence, the two filaments can be switched to one another on the primary side of the pulse transformer outside the betatron accelerating tube. (NSA of Japan)

9753 POWER SOURCE FOR CHARGED-PARTICLE DEVICES. Matsui, Isao; Takeda, Yasutsugu (to Hitachi Ltd.). Japanese Patent 1967-5310. Mar. 3, 1967. Filed May 7, 1965.

For charged-particle devices, such as the linear particle accelerator, separate pulse-generators are usually used for producing high-voltage pulses for particle acceleration and for producing pulses for taking out an electron beam (from the electron gun) and controlling the amount of beam. A method is proposed whereby the number of such pulse-generators can be reduced to one, leading to small size, light weight and the resulting high economy of the overall system, and the efficiency is not decreased. It includes the part where charged particles are emitted, the part where the charged particles are taken out and their amount is controlled by means of the electrodes, the part where the charged particles are accelerated, and the part where a control is done of the switch elements for the high-voltage pulse generator for the particle-acceleration part. The pulse voltages for the control electrodes and for the switch elements are supplied from the same pulse generator. (NSA of Japan)

9754 ION SOURCE. Ogawa, Kazuyuki; Kawasaki, Shinsuke (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-5314. Mar. 3, 1967. Filed July 24, 1965.

In the ion source proposed, which is operated by means of a radio frequency power, the configuration of its exit from where the ions are taken is designed at the optimum dimensions, considering the magnitude and the stability of the beam current. The H/D value of 0.6 to 0.8 is employed, where H is the distance between the top of the cathode canal and the end (in the same direction) of the insulating sheath, and D is the internal diameter of the insulating canal. (NSA of Japan)

9755 PARTICLE ACCELERATING DEVICE. Miyoshi, Katsuhiko; Hashimoto, Kenjiro (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-5313. Mar. 3, 1967. Filed Oct. 27, 1965.

In the particle accelerating device proposed, the evacuation of the accelerating tube, target holder etc., is improved. In the accelerating device, an oil (or mercury) diffusion pump is employed and a unique device is used as the cold trap. It consists of a diffusion pump, for evacuating the particle source, accelerating tube, target holder, etc.; and a cooling device, installed in the evacuating system for condensing the vapor flowing back from the diffusion pump. For operation of the cooling device, a high-pressure fluid is cooled by means of adiabatic expansion. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 9408, 9429, 9777, 9802, and 9921.

9756 (AERE-R-5536) SCAT AND SLAB: TWO COMPUTER CODES FOR THE COMPUTATION OF THERMAL NEUTRON SCATTERING CROSS SECTIONS. Hutchinson, P.; Scholfield, P. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1967. 44p. Dep. CFSTI. UK 8s. 0d.

The principles and method of operation of two computer codes, SCAT and SLAB, for the computation of inelastic scattering cross sections for thermal neutrons in the incoherent Gaussian approximation are described. SLAB computes the thermal neutron scattering law and SCAT the macroscopic energy-change cross sections, $\Sigma(E' \rightarrow E)$, in a suitable form for reactor calculations covering the energy range 0 to 10 eV and, over a more limited range, the linearly anisotropic component of the scattering $\Sigma_1(E' \rightarrow E)$. Both codes use a numerical Fourier transform method of evaluation, which is more flexible and more reliable than previous methods. (auth) (UK)

9757 (AERE-R-5616) APPLICATION OF A SEALED-TUBE NEUTRON GENERATOR TO THE DETERMINATION OF COPPER AND SILICON IN ALUMINIUM ALLOYS. Pierce, T. B.; Edwards, J. W.; Mapper, D. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1967. 9p. Dep. CFSTI. UK 1s. 9d.

A neutron generator installation is described which employs a sealed-tube as source of neutrons. The generator was used to determine copper and silicon in aluminium base alloys at levels of >1% and >0.3%, respectively; irradiation, cooling, and counting occupied a total of 3 minutes. (auth) (UK)

9758 (CEA-R-3254) SPECTROMETRIE DE NEUTRONS RAPIDES PAR TEMPS DE VOL. (Fast Neutron Spectrometry Using Time-of-Flight). Bertrand, Francoise; Voignier, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1967. 30p. (In French). Dep.

A thorough investigation of fast neutron time-of-flight spectrometry was made. The neutrons were obtained by the $T(d,n)\alpha$ reaction, and the time-of-flight was determined by the associated-particle method. A time resolution of 0.94 nanosec and an energy resolution of 5.6% were achieved. (D.C.W.)

9759 (EUR-3652) PROGRAMMES POUR L'EVALUATION DE LA SECTION EFFICACE DE FISSION A PARTIR DES DONNEES EXPERIMENTALES BRUTES. (Programs for Fission Cross-Section Evaluation from Raw Experimental Data). Cao, M. G. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Sept. 25, 1967. 120p. (In French). Dep.

Some programs that can be used to obtain the fission cross section σ_f from raw experimental data provided by analyzers relative to the fission neutron spectrum fission background noise, neutron flux, and the flux background noise spectrum are described. Apart from the program (PLOT), for plotting the σ_f curve, all the programs are written for the IBM 1401 computer The language used was SPS and the French FORTRAN. The PLOT program is written in FORTRAN II, version 3 for the IBM 7090 computer. (auth)

9760 (GA-8116) DIFFERENTIAL NEUTRON THERMALIZATION. Quarterly Technical Report, April 1, 1967–June 30, 1967. Whittemore, W. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 28, 1967. Contract AT(04-3)-167. 19p. Dep. CFSTI.

The large amount of additional data generated at the very end of the previous reporting period is included. In addition, plural scattering corrections estimated from the MUSE code were applied to all the scattering data accumulated in the program for liquid D_2O and reactor-grade graphite. The results for D_2O agree spectacularly well with the detailed predictions of McMurry for his aggregate model. Agreement is not as good when comparisons are made using the GASKET calculations with the frequency distribution for gaseous D_2O of Young and Koppel. The scattering law results for graphite corrected for plural scattering were compared with the GASKET calculations made with the frequency distribution of Young and Koppel. Good agreement is found between theory and experiment for every case except for the very lowest values of β where instrumental resolution affects the experimental data. (S.F.L.)

9761 (IN-1062) INCITE: A FORTRAN-IV PROGRAM TO GENERATE THERMAL NEUTRON SPECTRA AND MULTIGROUP CONSTANTS USING ARBITRARY SCATTERING KERNELS. Curtis, R. L.; Grimesey, R. A. (Idaho Nuclear Corp., Idaho Falls). Nov. 1967. Contract AT(10-1)-1230. 85p. Dep. CFSTI.

The computer program INCITE, which was written to calculate energy-dependent thermal neutron spectra and appropriate average multigroup cross sections using arbitrary scattering kernels, is described. The program employs a normalized Gauss–Seidel iteration technique to solve the energy-dependent integral form of the B-1 approximation to the Boltzmann transport equation. A maximum of 101 discrete energy points is utilized to represent the energy range. A library tape containing the proper absorption and scattering cross sections at these energy points is required. The current master library contains cross sections for 101 energy points in the energy range from 0.0 to 2.38 eV. The INCITE code is written in FORTRAN-IV language and is presently operating on the IBM-7040 and the UNIVAC-1108 digital computers. The running time for INCITE depends on the number of isotopes in the problem as well as the size of the data records that must be processed for each isotope. However, the running time for a typical problem, such as the sample problem contained in the report, should rarely exceed seven minutes on the IBM-7040 or one minute of the UNIVAC-1108. (auth)

9762 (NAA-SR-12493) DISCRETE ORDINATES REPRESENTATIONS OF THE SCATTERING KERNEL. O'Reilly, B. D. Sr.; Lewis, R. C. (Atomics International, Canoga Park, Calif.). Nov. 30, 1967. Contract AT(04-3)-701. 20p. Dep. CFSTI.

It is demonstrated that acceptably accurate DSN estimates of the slowing-down source can be obtained using a low-order truncation of the poorly convergent Legendre series expansion of the angle-energy transfer probability function, while very poor estimates can be expected when its angle-to-angle energy-to-energy representation is used. (auth)

9763 (ORNL-4130) CSP-I: A NEUTRON CROSS-SECTION AVERAGING PACKAGE FOR USE WITH THE 05R DATA TAPE. Yost, K. J.; Greene, N. M. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 111p. Dep. CFSTI.

A code package, identified as CSP-I, was developed for averaging cross-section data to be used as input to the S_n radiation transport codes. The code, designed to work from the 05R data tape, allows up to 200 energy groups with arbitrary boundaries and can accommodate up to a P_{10} approximation to elastic-scattering distributions. (auth)

9764 MEASUREMENT OF THE POLARIZATION OF THERMAL NEUTRON BEAMS OF MIXED VELOCITIES. Barkan, S.; Bieber, E.; Burgy, M. T.; Ketudat, S.; Krohn, V. E.; Rice-Evans, P.; Ringo, G. R. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 39: 101-7(Jan. 1968).

Three methods of measuring the polarizations of beams of thermal neutrons reflected from magnetized mirrors have been tried. These methods were based on depolarizers, a current-carrying foil (Dabbs foil), and a Stern–Gerlach magnet. The Stern–Gerlach method appears to be the most reliable; with reasonable care it is accurate to ±1%. (auth)

9765 MEASUREMENTS OF DIFFUSION PARAMETERS IN POLYETHYLENE. Santiago, S. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 357-64(Nov.-Dec. 1967). (In Spanish).

Pulsed measurements of neutron diffusion parameters in rectangular moderating assemblies of polyethylene are presented. Advanced methods were used for the determination of dead-time losses and for the numerical analysis of the neutron flux decay curves. Cooling-corrected extrapolation distances were used for buckling calculations. (auth)

9766 DIFFUSION OF NEUTRONS IN BENZENE. Sancho, L.; Verdaguer, F. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 351-5(Nov.-Dec. 1967). (In Spanish).

Pulsed neutron measurements of diffusion parameters in benzene at 20°C are presented. The transport mean free path used in buckling calculations includes a cooling effect correction using the average flux method. The values obtained are $\Sigma_a v = 2933 \pm 25$ s^{-1}, $D = 49395 \pm 500$ cm^2 s^{-1}, $C = 16927 \pm 2200$ cm^4 s^{-1}. (auth)

9767 CALCULATION OF THE FUNDAMENTAL MODE OF THE ONE-VELOCITY NEUTRON TRANSPORT OPERATOR. Bansal, N. K.; Ghatak, A. K. (Indian Inst. of Tech., New Delhi). Can. J. Phys., 12: 3793-3802(Dec. 1967).

Some results are reported on the asymptotic behavior of a neutron pulse injected into a slab using monoenergetic transport theory including the effects of the anisotropic scattering cross section in the laboratory system. The calculations were performed in the P_1 and P_2 approximations. These results are compared with the exact numerical calculations and with the recent pulsed neutron experiments in fast nonmultiplying nonmoderating assemblies where the decay of an essentially monoenergetic burst of neutrons is studied. (auth) (Canada)

9768 RECONSTRUCTION OF PERTURBED NEUTRON SPECTRA FROM THE RESPONSE OF SELECTED RESONANCE ABSORBERS. Jedruch, Jacek. University Park, Pa., Pennsylvania State University, 1966. 171p.

The purpose of this study was to determine the applicability of the neutron activation technique to extracting quantitative information on the degree of perturbation induced in a thermal neutron spectrum by the presence of a resonance absorber in the composition of the medium supporting the spectrum. The mathematical model used is based on the solution of the neutron thermalization equation in associated Laguerre polynomials of order one with a Maxwellian weighting function. An experiment was performed to demonstrate how the required coefficients of the spectral expansion can be obtained from the application of a proper response matrix to a vector composed of experimental activation integrals. To obtain quantitative information on the reproducibility and accuracy of the method, in the present state of knowledge of neutron cross sections and decay schemes of the activants, four neutron test spectra were generated. A neutron beam, taken from the face of a TRIGA-type reactor, was introduced into a cylindrical tank of approximately 20 liters volume, which contained either deionized water, or water solution of $CdSO_4$ of various concentrations. Each resulting spectrum was sensed repeatedly by irradiating in it simultaneously ten activation probes in the form of approximately one ml of a dilute solution of the nitrate of the following elements: dysprosium, europium, lutetium, ytterbium, iridium, indium, rhenium, holmium, terbium, and thulium. Multichannel gamma scintillation spectroscopy was used to measure the induced activity, and the areas under the selected photopeaks were reduced to the activation integrals by performing on a digital computer a least squares fit to a Gaussian shape and applying appropriate corrections for the radioactive decay, length of irradiation and counting, density of activant, gamma-line intensity and efficiency of crystal. The experimental activation integrals thus obtained formed the elements of the activation vector to which a response matrix was applied to unfold the activating neutron spectrum. The elements of the response matrix were generated by performing on a digital computer numerical integrations over the scalar products of each possible permutation of the first ten associated Laguerre polynomials of order one, weighted by a Maxwellian function, with each of the neutron cross sections of the ten activants, over the energy range $0 \leq E \leq 1$ eV. The neutron cross sections were generated from resonance parameters through the application of Breit-Wigner formalism. The response matrix was inverted in steps starting with the (2×2) size and multiplied at each step by an activation vector of compatible composition and size. Using the resulting coefficients the spectrum was reconstructed and compared to the spectral shapes measured by other workers in media of the same composition, by neutron time-of-flight technique. The spectra converged with three of four terms. Beyond five terms oscillations set into the solution. It was demonstrated that the second and third of the resulting coefficients are sensitive to changes in the concentration of the spectrum perturbing resonance absorber and their variation can be used as a measure of its density. With three to four coefficients the changes of the order of 20 percent in the density of the absorber can be obtained with activation integrals measured to 10 percent accuracy. It is believed that better resolution would require an improvement in the knowledge of the isomeric cross section of ^{151}Eu and ^{168}Yb, and measurements of activation integrals to better than 5%. Activation of In, Re, Ho, Tb and Tm was found not useful for the application of this method. Spectral expansions to energies above 1 eV were unsuccessful due to the effect of cumulative error. (Diss. Abstr.)

9769 NEUTRON-GENERATING DEVICE. Adachi, Takeshi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-15400. Aug. 30, 1966. Filed July 15, 1963.

A vertical neutron generator with simplified shielding at the neutron-producing target is described. It consists of the support in the form of a bottom-open box on the floor with a hole at the center of its top, a place for the target below the hole which is near the floor level, the accelerating tube etc. mounted on top of the box support running through the hole and the target area, and layers of suitable shielding materials which surround the target area within the support box. (NSA of Japan)

Nuclear Properties and Reactions, A≤ 5

Refer also to absiracts 9047, 9531, 9617, 9820, 9960, and 9974.

9770 ELASTIC SCATTERING OF DEUTERONS BY ALPHA PARTICLES. Mani, G. S. (Manchester Univ., Eng.); Tarratts, A. Nucl. Phys., A107: 624-38(1968).

Elastic scattering of deuterons by alpha particles for deuteron energies from 3 to 14 MeV was investigated for 20 angles. Complex phase shift analysis was performed on the data. There does not seem to be any indication of negative-parity states in ^{6}Li as reported by Senhouse and Tombrello. (auth)

9771 SEARCH FOR A BOUND STATE OF THREE NEUTRONS. Debertin, K.; Roessle, E. (Univ., Frankfurt am Main). Nucl. Phys., A107: 693-4(1968).

The break-up reaction ^{3}H(n,p)3n was studied at $E_n = 14.1$, 18, and 21.5 MeV. No evidence for a bound state of three neutrons was found. (auth)

9772 CAPTURE OF PROTONS BY DEUTERONS. Woelfli, W.; Boesch, R.; Lang, J.; Mueller, R.; Marmier, P. (Laboratorium fuer Kernphysik ETH, Zurich). Helv. Phys. Acta, 40: 946-72(Nov. 15, 1967). (In German).

The differential cross section of the reaction ^{2}H(p,γ)^{3}He was measured at 90° to the incident proton beam over the energy range from 2 to 12 MeV. In addition, the angular distribution of the gamma radiation was determined up to energies of 5.03 MeV. The target consisted of deuterium gas at a pressure between 400 and 1200 torr. The gamma rays were detected with a 3 × 3 NaI-crystal. From the experimental data, the total cross section σ_{tot} and the parameters a/b and β of the angular distribution were evaluated. With the aid of the principle of detailed balance, these results were compared with the theoretical predictions for the inverse photonuclear reactions ^{3}He(γ,p)^{2}H and ^{3}H(γ,n)^{2}H. Except for the ratio a/b, good agreement ensued both in form and absolute magnitude, when the Gunn–Irving expression (size parameter $\mu^{-1} = 2.5$ F, S′-state probability 0.5%) is taken for the ground-state wave function of the 3-body nuclei. It is shown that the observed discrepancy in the ratio a/b can not be explained even if the influence of the Coulomb and nuclear forces between the deuteron and the proton in the continuum state are taken into account. (auth)

9773 PHOTODISINTEGRATION OF HELIUM WITH VELOCITY-DEPENDENT POTENTIALS. Srivastava, B. K. (Indian Inst. of Tech., Kharagpur); Jain, S. C. Phys. Rev., 164: 1223-5(Dec. 20, 1967).

The sum rules of Levinger and Bethe are applied to calculate the integrated (σ_{int}) and bremsstrahlung-weighted (σ_b) cross sections of ^{4}He by using a two-body central velocity-dependent potential both in ^{1}S and ^{3}S states. For the wave function, a modified Irving wave function whose parameters were determined from a variational calculation of the binding energy of ^{4}He is used. There is reasonably good agreement of the values of σ_{int} and σ_b with those of Goldhammer and Valk and with the experimental values of Gorbunov and Spiridonov. Moreover, the results confirm the conclusion of Dohnert and Rojo that the velocity-dependent correlations increase σ_{int} by 14% over the values obtained with purely central forces. (auth)

9774 CHARGE FORM FACTOR OF THE ALPHA PARTICLE. Jain, S. C. (Allahabad Univ., India); Srivastava, B. K. Phys. Rev., 164: 1226-8(Dec. 20, 1967).

The charge form factor $F_E(q^2)$ of the α particle (^{4}He) is calculated analytically with a modified Irving wave function. The parameters of the wave function were determined from a variational calculation of the binding energy of ^{4}He using a central velocity-dependent potential. Good agreement between the values obtained for $F_E(q^2)$ and those obtained from electron-helium elastic-scattering experiments is found. Also, the agreement with calculations using hard-core potentials is satisfactory. (auth)

9775 POLARIZATION OF PROTONS FROM THE D(d,p)T REACTION. Porter, L. E.; Haeberli, W. (Univ. of Wisconsin, Madison). Contract AT(11-1)-gen-7. Phys. Rev., 164: 1229-34(Dec. 20, 1967). (COO-7-0420).

The polarization of protons from the D(d,p)T reaction was measured for eight deuteron energies between 2.1 and 14.1 MeV. For each deuteron energy, observations were made at nine laboratory angles between 10 and 70°. Scattering from helium was used as the polarization analyzer. For energies above 6 MeV, the polarization is positive at all angles with a maximum near 45°. The highest polarization was observed at 12.1 MeV where the peak value is about

0.5. The angular dependence of the polarization was fitted in terms of a sum over associated Legendre functions. To assure a smooth dependence of the coefficients on energy, they were represented by a power series (energy-dependent analysis). A comparison of the present results with measurements of the neutron polarization in the mirror reaction D(d,n)^{3}He indicates that the proton polarization is larger by a factor of about 1.4. (auth)

9776 TWO- AND THREE-BODY PHOTODISINTEGRATION CROSS SECTIONS OF ^{3}H AND ^{3}He. Knight, J. M. (Univ. of South Carolina, Columbia); O'Connell, J. S.; Prats, F. Phys. Rev., 164: 1354-9(Dec. 20, 1967).

Electric-dipole photodisintegration cross sections of ^{3}H and ^{3}He into deuteron plus nucleon and into three nucleons are calculated using simple zero-range forms for the initial- and final-state wave functions. Final-state interactions between nucleon pairs in S states are taken into account. Shape fits to the experimental data are obtained, but the required normalization of the ground-state wave function is found to differ between two- and three-body breakup. (auth)

9777 HIGHLY POLARIZED NEUTRONS FROM THE s-WAVE T(d,n)^{4}He AND D(t,n)^{4}He REACTIONS. Ohlsen, Gerald G. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Rev., 164: 1268-74(Dec. 20, 1967). (LA-DC-8943).

Formulas are presented in which the polarization of neutrons from the s-wave T(d,n)^{4}He and D(t,n)^{4}He reactions are expressed in terms of the projectile polarization and two real parameters which characterize the reaction. Neutron polarization limits are calculated from the presently available information about the range of possible values of these parameters. Several experiments are suggested by which these parameters can be determined. When this information is available, approximately 14-MeV neutrons with a large and accurately known polarization can be produced with the aid of a polarized ion source. The advantages, for this application, of a polarized ion source which can select a single nuclear substate are pointed out. The construction of a polarized neutron generator with useful intensities and large polarization appears to be feasible at the present time. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 9770, 9818, 9820, 9839, 9918, and 9961.

9778 (ANU-P-388) ENERGY LEVELS OF ^{17}O FROM ^{13}C(α,α_0)^{13}C AND ^{13}C(α,n)^{16}O. Kerr, G. W.; Morris, J. M.; Risser, J. R. (Australian National Univ., Canberra. Research School of Physical Sciences). [1967]. 33p. Dep.

The ^{13}C(α,α_0)^{13}C cross section at cms angles 54.7, 90, 149.4, and 169.6° and the ^{13}C(α,n)^{16}O cross section at 0° were measured over the range of α-particle energies 3.5 to 6.5 MeV. Angular distributions for the ^{13}C(α,n)^{16}O reaction were measured at a number of energies within this range. From a dispersion theory analysis, a consistent set of J^π and partial width values were obtained for eleven states of the compound nucleus ^{17}O with excitation energies between 9 and 10 MeV. (auth)

9779 (JINR-P1-3598) POGLOSHCHENIE π-MEZONOV NA ^{12}C S OBRAZOVANIEM ^{8}Li. (Absorption of π-Mesons by ^{12}C With the Production of ^{8}Li). Zelenskaya, N. S.; El-Nagar, N.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 7p. (In Russian). Dep.

The energy spectra and the angular correlations of finite particles are calculated for the reaction ^{12}C(π^-,n^{3}He)^{8}Li in the framework of a direct absorption mechanism of π mesons on a few-nucleon cluster. The results agree well with the experimental data. (auth)

9780 (NP-17203) ENERGY LEVELS OF ^{16}O IN THE VICINITY OF 13 MeV. III. Morris, J. M.; Kerr, G. W.; Ophel, T. R. (Australian National Univ., Canberra. Research School of Physical Sciences). [1967]. 32p. Dep.

Angular distributions and excitation functions of the elastic scattering reaction ^{12}C(α,α_0) were analyzed in terms of complex phase shifts for the range of incident alpha particle energies 6.6 MeV $\leq E_\alpha \leq$ 8.4 MeV. The results confirm the presence of four levels in the compound nucleus system ^{16}O at excitation energies of 13.01, 13.08, 13.12, and 13.25 MeV, respectively. Level parameters for the states at 13.01 and 13.12 MeV were deduced with more accuracy than from previous measurements. (auth)

9781 THE CAPTURE OF π^- MESONS IN OXYGEN AND IN OTHER NUCLEI. Fowler, P. H.; Mayes, V. M. (Univ. of Bristol, Eng.). Proc. Phys. Soc. (London), 92: 377-89(Oct. 1967).

An attempt was made to study the detailed characteristics of the capture of π^- mesons in light elements, and in particular oxygen. The study was made as an initial investigation into the feasibility of the use of π^- mesons in radiation therapy for the treatment of carcinomas. There is a yield of 1.77 ± 0.08 multiply charged particles per π^- capture in oxygen, with a mean kinetic energy of 6.9 MeV. These particles have a high relative biological efficiency and low oxygen enhancement ratio, and the biological effect of an irradiation with π^- mesons would be characterized by these heavy particles. The frequency distribution of the various modes of interaction are given together with energy spectra for protons, alpha, and heavier particles. (auth) (UK)

9782 STUDY OF THE (d,p) REACTION IN THE 1p SHELL. Schiffer, J. P.; Morrison, G. C.; Siemssen, R. H.; Zeidman, B. (Argonne National Lab., Ill.). Phys. Rev., 164: 1274-84(Dec. 20, 1967).

Angular distributions for the (d,p) reaction leading to bound states in the 1p shell were obtained at E_d = 12 MeV for all stable targets. Spectroscopic factors obtained in distorted-wave Born-approximation (DWBA) analyses with average parameters are in surprisingly good agreement with those obtained in the shell-model calculations of Cohen and Kurath. The oscillating structure of the angular distributions at backward angles tends to be qualitatively reproduced by the DWBA calculations, although the amplitudes of the oscillations and the magnitudes of the backward cross sections are very sensitive to details of the calculations. J-dependent effects, similar to those found in heavier nuclei, but with some complications, are also found here. (auth)

9783 EXCITED STATES IN ^{11}B OBSERVED IN THE ^{7}Li(α,γ) REACTION. Paul, P. (Stanford Univ., Calif.); Puttaswamy, N. G.; Kohler, D. Phys. Rev., 164: 1332-42(Dec. 20, 1967).

Excited states in ^{11}B between 9.5 and 11 MeV were studied by use of the ^{7}Li(α,γ)^{11}B and ^{7}Li(α,α')^{7*}Li (478 keV) reactions. The thin-target excitation function of the capture reaction, which was obtained at 90° for the ground-state transition from 1.3- to 3.2-MeV bombarding energy, displays a structured peak around 2.5 MeV with a peak differential cross section of 2 μb/sr. A transition to the first excited state was not observed, setting an upper limit for $d\sigma/d\Omega < 0.2$ μb/sr. By comparing the yield with that of the ^{13}C(p,γ_0)^{14}N reaction, an absolute peak cross section of 22.5 μb/sr (±20%) was obtained for the 951-keV resonance. Reinvestigation of the inelastic scattering cross section over the same bombarding energy range, coupled with a Breit–Wigner analysis, yielded for the states at 9.87, 10.26, and 10.62 MeV the assignments for spin and parity of $^3/_2{}^+$, $^1/_2{}^\pm$ or $^3/_2{}^\pm$, and $^7/_2{}^+$, respectively. This is essentially in agreement with the recent work by Cusson on elastic and inelastic α scattering. Analysis of the radiative capture cross sections (assuming isotropy) with resonance parameters from the particle reactions gives the following ground-state γ widths for the established states: <0.5 eV (at 9.88 MeV); 17 eV (10.26 MeV); 1 eV (10.32 MeV); ≤0.2 eV (10.61 MeV). There is evidence for a new state at 10.45 ± 0.05 MeV with Γ (c.m.) ≃140 keV and $(2J + 1)\Gamma_\gamma = 10$ eV. Possible analog states in ^{11}C were reinvestigated with the ^{10}B(p,γ_0)^{11}C reaction. The γ transition strengths observed in ^{11}B do not agree with present shell-model calculations. (auth)

9784 EVEN-PARITY STATES OF ^{16}O IN A PAIRING-PLUS-QUADRUPOLE MODEL. Muenchow, L.; Jaeger, H. U. (Central Inst. for Nuclear Research, Rossendorf, Ger.). Nucl. Phys., A107: 671-93(1968).

An outline is given of the generalized quasiboson approximation, and this method is used to investigate the interplay of pairing and Q-Q force in the lowest even-parity states of ^{16}O. In particular, the equilibrium deformation of the self-consistent field in the ground and first excited state and the dependence of the energies and some transition rates on the interaction parameters are discussed. (auth)

9785 MUON CAPTURE IN BORON AND OXYGEN. Deutsch, J. P.; Grenacs, L.; Igo-Kemenes, P.; Lipnik, P.; Macq, P. C. (Univ., Louvain, Belg.). Nuovo Cim. (10), 52B: 557-9(Dec. 11, 1967).

A measurement of the meson (μ^-) capture rates of ^{11}B and ^{16}O leading to the bound states of ^{11}Be and ^{16}N is summarized. The results for ^{11}B → ^{11}Be are compared with theoretical predictions while the results for ^{16}O → ^{16}N are compared with other experimental data. (D.C.W.)

9786 INELASTIC ELECTRON SCATTERING FROM THE 3.56 MeV EXCITED STATE OF ^{6}Li. Hutcheon, R. M.; Drake, T. E.; Stobie, V. W.; Beer, G. A.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon, Can.). Nucl. Phys., A107: 266-72(1968).

The form factor for the excitation of the 3.56 MeV level in ^{6}Li was measured using the 140 MeV Saskatchewan electron linear accelerator. A simple analysis of the data using shell-model harmonic oscillator wave functions indicates that the harmonic oscillator parameter of the p-shell nucleons in ^{6}Li must be substantially larger than that of the s-shell nucleons. A large discrepancy between the present results and those of Bernheim and Bishop is due to problems in analysis of their data caused by the presence of a large continuous cross section underlying at least the first two excited states of ^{6}Li. (auth)

9787 ELASTIC SCATTERING OF ^{6}Li ON ^{12}C AT 20 MeV. **Bethge, K.; Meier-Ewert, K.; Pfeiffer, K. O. (Univ., Heidelberg). Z. Phys., 208: 486-9(1968).**

The elastic scattering of lithium nuclei from carbon was measured at $E_{lab} = 20$ MeV. The angular distribution obtained was fitted by an optical model calculation. Parameter sets and the corresponding transmission coefficients are given. (auth)

9788 ANGULAR DISTRIBUTION OF NEUTRONS FROM THE ^{6}Li(^{6}Li,n)^{11}C REACTION AT 4.10 MeV. **Bahnsen, R. M.; Carpenter, R. T. (Univ. of Iowa, Iowa City). Phys. Rev., 164: 1235-40(Dec. 20, 1967).**

Angular distributions of neutrons from the ^{6}Li(^{6}Li,n)^{11}C reaction were measured at 4.1-MeV bombarding energy for all bound levels in ^{11}C except the ground state. The 6.39–6.41-MeV doublet was not resolved. The angular distributions, generally, agree in relative magnitude and shape with those from analog states in the mirror reaction ^{6}Li(^{6}Li,p)^{11}B. This result is most easily understood by assuming that both reactions proceed predominately by compound-nucleus formation. The 8.43-MeV level in ^{11}C is observed to decay by γ emission even though it is unbound to α-particle emission by 890 keV. This retardation of the α decay can not be understood as being due to the Coulomb barrier alone. (auth)

9789 STUDY OF LEVELS IN ^{8}Be OBTAINED BY THE REACTION ^{10}B(d,$\alpha\alpha$)α AT 0.6 TO 2 MeV. Longequeue, J. P.; Cavaignac, J. F.; Giorni, A.; Bouchez, R. (Univ., Grenoble, France. CEN, Grenoble, France). Nucl. Phys. A107: 467-75(1968). (In French).

Correlations between three α-particles from ^{10}B + d reactions at 0.6, 0.9, 1.45, and 1.9 MeV were analyzed with a two-parameter analyzer. The three-α decay is mainly a sequential process via the 0^+(g.s.), 2^+(2.9 MeV), 4^+(11.4 MeV), and 2^+(16.6 and 16.9 MeV) states of ^{8}Be. The positions and widths of these levels were studied. The width of the 4^+ level is smaller ($\Gamma \approx 3$ MeV) than the value ($\Gamma \approx 7$ MeV) found by α–α scattering. (auth)

9790 STUDY OF UNBOUND LEVELS IN ^{14}N BY THE ^{12}C(^{3}He,pγ)^{14}N REACTION. Gallmann, A.; Haas, F.; Heusch, B. (Univ., Strasbourg). Phys. Rev., 164: 1257-63(Dec. 20, 1967).

The 8.49-, 8.96-, and 9.17-MeV unbound levels of ^{14}N were studied by particle-γ angular-correlation measurements for the ^{12}C(^{3}He,pγ)^{14}N reaction at 8.92 MeV bombarding energy. These levels were found to γ decay in competition with proton decay with the width ratios $\Gamma_p/\Gamma_\gamma = 3.7 \pm 1.1$, 4.09 ± 0.49, and 10 ± 3, respectively. The spin and parity of the ^{14}N 8.96-MeV level were definitively established as $J^\pi = 5^+$. The γ widths of the E2 transitions from the 8.96- and 8.49-MeV levels were compared with shell-model predictions. In addition, an unusual result was obtained for the ^{14}N 7.03-MeV level. While at $E_{^{3}He} = 5.11$ MeV, the m = 0 substate of this level was predominantly populated, it was found that at $E_{^{3}He} = 8.92$ MeV the $|m| = 1$ substates were strongly populated. The latter was interpreted as due to s = 1 transfer in a possible heavy-particle stripping reaction. (auth)

9791 CROSS SECTIONS FOR THE ^{12}C(π^-,π^-n)^{11}C AND ^{65}Cu(p,pπ^+)^{65}Ni REACTIONS. **Selleri, F. (Univ., Bologna). Phys. Rev., 164: 1475-8(Dec. 20, 1967).**

The total cross section for simple particle–transfer reactions like ^{12}C(π^-,π^-n)^{11}C and ^{65}Cu(p,pπ^+)^{65}Ni are shown to be markedly affected by kinematical momentum–transfer-dependent factors. Inclusion of these factors gives cross sections in good agreement with experiment. (auth)

9792 ^{11}B-INDUCED SINGLE-NUCLEON TRANSFER REACTIONS. **Poth, J. E.; Overley, J. C.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev., 164: 1295-1315(Dec. 20, 1967).**

Single-nucleon transfer reactions induced by 115.9-MeV ^{11}B ions incident on targets of ^{12}C, ^{13}C, ^{14}N, ^{15}N, ^{16}O, and ^{20}Ne were studied with the primary objectives of elucidating the reaction mechanism and investigating the utility of such reactions as spectroscopic probes. Reaction-product energy spectra from the (^{11}B,^{10}B) and (^{11}B,^{10}B) transfer reactions were recorded simultaneously for each target using a dE/dx and E particle identification system which permitted isolation and study of individual residual states. All reactions exhibited highly selective population of residual states, consistent with a particularly simple reaction model involving the direct transfer of a nucleon to an unexcited target core. Evidence was adduced for a mechanism favoring the population of high-angular-momentum states of this configuration. For all targets, ratios of measured cross sections for neutron and proton transfer reactions leading to analog residual states were used to obtain the relative ^{10}B + n and ^{10}Be + p parentage of the ^{11}B ground state on the assumption of charge independence throughout the reactions. Calculations based on available p-shell wave functions were found to be in good accord with the experimental results. (auth)

9793 ON THE QUASI-ELASTIC MECHANISM OF THE (α,2α) REACTION AT LOW AND INTERMEDIATE ENERGIES. **Balashov, V. V. (Moscow State Univ.); Meboniya, D. V. Nucl. Phys., A107: 369-81(1968).**

The (α,2α) reaction is considered in the impulse approximation of the interaction of the incident α-particle with an α-cluster in the nucleus. Numerical calculations are made for the case of symmetrically outgoing α-particles in the (α,2α) reaction on ^{6}Li, ^{7}Li, ^{9}Be, ^{12}C and ^{16}O at incident energy about 25 MeV. (auth)

9794 DEUTERON DISINTEGRATION BY Au, Rh, Cu, AND C FROM 8 TO 15 MeV. **May, E. C.; Cohen, B. L.; O'Keefe, T. M. (Univ. of Pittsburgh). Phys. Rev., 164: 1253-6 (Dec. 20, 1967).**

Deuteron disintegration by Au, Rh, Cu, and C was studied with a p-n correlation technique. In all targets, the neutrons tend to go predominantly in the forward direction. For heavier targets and lower deuteron energies, the protons are emitted predominantly on the same side of the beam as the neutrons and at larger angles (although there is a small secondary peak on the opposite side of the beam), while for lighter targets and higher deuteron energies, they are emitted predominantly on the opposite side of the beam from the neutrons. From this it is surmised that the former behavior characterizes a breakup by the Coulomb force, while the latter behavior characterizes a breakup by the nuclear force; this conclusion is supported by theoretical estimates. From the energy sharing between neutrons and protons, the average radius at which breakup occurs is determined; as expected, it is much larger for Coulomb than for nuclear breakup, but in all cases it is more than twice as large as the usual "nuclear radius." (auth)

9795 (p,d) OR (p,pd) REACTIONS FROM PROTON BOMBARDMENT OF ^{6}Li AT 14.7 MeV. **Seifert, Aurel Martin. New York, Columbia Univ., 1967. 80p.**

Thesis.

Relative differential cross sections are presented for the formation of deuterons in the two competing processes from the reactions: $Li^6(p,d)Li^5$ and $Li^6(p,pd)He^4$. For the pick-up process leading to the ground state of Li^5 results are available for laboratory angles from 10 to 60°. The shape of the spectrum clearly favors an $l = 1$ orbital for the picked-up neutron. The second reaction, which leads to a continuous spectrum has been observed for laboratory angles from 15 to 90°. This continuous spectrum is attributed almost entirely to the very broad 3.82-MeV first excited level of Li^5. Its measured average energy of 3.89 ± 0.10 MeV corresponds to an excited state of Li^5 at 3.72 ± 0.10 MeV, with a full width Γ estimated to be 6.3 ± 0.5 MeV. A small "peak" at low energies was attributed to a contribution from the next excited level of Li^5 at 16.64 MeV. The integrated relative cross section for the latter process seems to exhibit symmetry about 90° in the center of mass system, from 60° to 113°, and both processes exhibit absolute maxima at the same forward angles: $\Theta_{Lab} = 22.5 \pm 0.5°$. (Diss. Abstr.)

9796 ENERGY LEVELS AND ELECTROMAGNETIC TRANSITIONS IN ^{15}N FROM THE ^{13}C(^{3}He,pγ)^{15}N REACTION. **Phillips, Gary Wilson. College Park, Md., Univ. of Maryland, 1967. 124p.**

Thesis.

Electromagnetic branching ratios were measured by the ^{13}C(^{3}He,pγ)^{15}N reaction for levels in ^{15}N at 8.31, 8.57, 9.05, 9.16, 9.23, 9.76, 0.83, 9.93, 10.07, and 10.45 MeV in excitation energy. Thin self-supporting targets were prepared by cracking methyl iodide enriched to 60% in ^{13}C. Proton-singles measurements were made with a magnetic spectrometer at angles of 20 and 120° with respect to the beam direction and at incident ^{3}He energies of 2 and 5 MeV. Gamma-ray coincidence spectra were taken with the gamma rays detected by a 5 in. diam. × 5 in. NaI(Tl) crystal. From the coincidence spectra, gamma-ray branching ratios were extracted. For levels at 8.31, 8.57, 9.05, and 9.93 MeV, comparison was made with electromagnetic branching ratios calculated from theoretical wave functions. From the proton-singles spectra, excitation energies were obtained for levels in ^{15}N of 9.054 ± 0.0035, 9.225 ± 0.0030, 9.829 ± 0.0039, and 10.072 ± 0.0035 MeV. Proton-gamma ray angular-correlation measurements were made for the levels at 9.05, 9.16, and 9.23 MeV. From theoretical fits to the angular correlations, a value of $J = 3/2$ was obtained for the spin of the 9.16-MeV level. The 9.05-MeV level was found to be either $J = 1/2$ or $3/2$, and the 9.23 MeV level was found to be probably $J = 3/2$ with a small probability of $J = 1/2$. (Diss. Abstr.)

9797 MEASUREMENT OF THE NUCLEAR RECOIL POLARIZATION IN THE REACTION $^{11}B(d,p)^{12}B$. Pfeiffer, Loren Neil. Baltimore, Johns Hopkins Univ., 1967. 126p.

Thesis.

Measurements were made of the polarization of the ^{12}B recoil nuclei resulting from the $^{11}B(d,p)^{12}B$ reaction for E_d in the range of 0.90 to 3.20 MeV. The polarization is observed by measuring the β-decay asymmetries of the ^{12}B recoil nuclei with respect to the reaction plane. The ^{12}B recoil nuclei in different excited states are separated kinematically, and then are stopped in various solids in the presence of a small magnetic field normal to the reaction plane. The sign of the observed polarization for all measurements is positive, following the usage of the Basel convention. The magnitude of the polarization is strongly dependent on E_d, the recoil emission angle, and the material used to stop the recoils. An experimental survey of stopping materials indicates the noble metals, Au, Pt and Pd preserve the ^{12}B polarization, and the organic materials Teflon and Mylar cause complete depolarization. It is found that the polarization of ^{12}B nuclei can be maintained in palladium metal at room temperature using holding fields smaller than 20 gauss. For recoils stopped in platinum metal, a magnetic field of 150 gauss is required to maintain the nuclear polarization. The ^{12}B recoil polarization plotted as a function of E_d shows definite structure. Polarization resonances are observed at 1.50, 2.10, and 3.00 MeV. At these energies the measured relative polarizations are $+ 8.01 \pm 0.30\%$, $+ 4.29 \pm 0.25\%$, and $+ 3.86 \pm 0.27\%$, respectively, for a platinum metal recoil stopper and a 49° (LAB) recoil angle. These resonances are tentatively identified with states of the ^{13}C compound nucleus near 20 MeV and at 20.52 and 21.28 MeV. The excitation energies of these ^{13}C states are at 1.60, 2.18, and 3.08 MeV for deuterons on ^{11}B. It is believed that the polarization resonances result from an interference, between direct interaction and two particle compound resonance processes. (Diss. Abstr.)

9798 ENERGY DEPENDENCE OF THE $^{10}B(^6Li,\alpha)^{12}C$ AND $^9Be(^6Li,p)^{14}C$ REACTION CROSS SECTIONS. Seale, Wayne Allan. Iowa City, Iowa, Univ. of Iowa, 1967. 49p.

Thesis.

The cross sections of the reactions $^{10}B(^6Li,\alpha_0)^{12}C$ and $^{10}B(^6Li,\alpha_1)^{12}C^*$ were measured at 0° for ^6Li energies of 3.20 to 13.60 MeV. The $^9Be(^6Li,p_0)^{14}C$ and $^9Be(^6Li,p_1)^{14}C^*$ cross sections at 0° were measured for ^6Li energies ranging from 3.84 to 6.40 MeV. The analysis of the yield curves in terms of fluctuation theory gave values of the average level width, Γ, of 1.40 MeV for ^{16}O at 36-MeV excitation and approximately 0.40 MeV for ^{15}N at 28-MeV excitation. From the same data, it was found that there is a considerable contribution of direct reaction mechanism as well as compound nucleus to both reactions. (Diss. Abstr.)

9799 LEVELS IN ^{18}O THROUGH THE RADIATIVE CAPTURE OF ALPHA PARTICLES BY ^{14}C. Lee, Floyd Denman. Lawrence, Kan., Univ. of Kansas, 1966. 116p.

Thesis.

Isotopic targets made from 99% enriched $Ba^{14}CO_3$ were used to study the $^{14}C(\alpha,\gamma)^{18}O$ reaction for incident alpha-particle energies between $E_\alpha = 0.50$ and 3.00 MeV. Three previously reported resonances at $E_\alpha = 1140$, 1790 and 2330 keV were observed, as well as a new resonance at $E_\alpha = 2440$ keV. Detailed coincidence studies were made to determine the gamma-ray decay schemes at each resonance. The spins and parities of eight different excited states of energy greater than 3.92 MeV in ^{18}O were assigned or confirmed from the results of double correlation measurements obtained at each resonance together with a multiparameter triple correlation measurement at the 1790-keV resonance. Also determined were the branching ratios and multipole mixing ratios for the gamma ray cascades observed in the decay of the four resonance states. Of particular interest among the results was a $J = 1^{(-)}$ assignment for the 4.45-MeV state, a $J = 5^-$ assignment for the 8.13-MeV state and a confirmation of the $J = 0$ assignment for the 5.33-MeV state. An unsuccessful attempt was made to fit the $J = 5^-$ state into a predicted band of negative-parity states, the initial member of which was assumed to be the 4.45-MeV 1^- state. A detailed account and FORTRAN listing of six computer programs, written for an IBM 1620 computer to facilitate the reduction and analysis of experimental data, are presented as an appendix to the dissertation. An additional appendix deals with the spectral analysis of gamma-ray coincidence data recorded with a multiparameter pulse-height analyzer. (Diss. Abstr.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 8039, 8366, 9791, 9792, 9794, 9849, 9850, 9873, 9910, 9921, 9939, 9962, and 9975.

9800 (COO–535-571) TECHNICAL PROGRESS REPORT [ON NUCLEAR PHYSICS]. (Colorado Univ., Boulder. Nuclear Physics Lab.). Nov. 1, 1967. Contract AT(11-1)-535. 93p. Dep. CFSTI.

The energy levels of several nuclei were investigated using charged-particle reactions and scattering; optical-model fits to the data were made. Theoretical formalisms for nuclear reactions and models were also studied. Self-supporting isotopic targets were prepared using vacuum evaporation, and lithium-drifted detectors were fabricated and tested. (D.C.W.)

9801 (HMI-B–50) JAHRESBERICHT 1966. (Annual Report, 1966). (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Apr. 1967. 174p. (In German). Dep.

The annual report for 1966 of the Hahn–Meitner Institut is presented. Studies made in nuclear chemistry, mathematics, nuclear physics, radiochemistry, electronics, reactor physics, and radiophysics are briefly indicated. Abstracts are presented of completed studies. A publication list is given for each section. (J.S.R.)

9802 (NYO–1082-9) REACTION STUDIES WITH FAST NEUTRONS. Report of Progress to October 31, 1967. Peck, R. A. Jr.; Maxson, D. R. (Brown Univ., Providence, R. I. Dept. of Physics). Nov. 1, 1967. Contract AT(30-1)-1082. 23p. Dep. CFSTI.

Previously unreported research on the time-of-flight technique and on isobaric analog resonances excited in proton elastic scattering by ^{54}Cr is reported. Modifications to the fast neutron facility are also summarized. (D.C.W.)

9803 (ORNL-TM–2060) EXCITATION FUNCTIONS OF RADIONUCLIDES PRODUCED BY 0 TO 60-MeV PROTON REACTIONS IN SILICON. Sheffey, David Wells (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 43p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Excitation functions for the production of radioisotopes including ^{28}Al, ^{29}Al, ^7Be, ^{18}F, ^{27}Mg, ^{22}Na, and ^{24}Na in proton reactions with Si at 0 to 60 MeV were measured. Target foils were bombarded in the Oak Ridge Isochronous Cyclotron, and the gamma radiation from each foil was subsequently analyzed using a high-resolution Ge(Li) gamma spectrometer. The experimental data were compared with cross sections predicted by an evaporation theory for compound nuclei. (D.C.W.)

9804 INVESTIGATION OF γ RAYS FROM THE $^{26}Mg(p,\gamma)^{27}Al$ REACTION AT $E_p = 2322$ keV. Koval, A. A.; Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. (Engineering Physics Inst., Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 637-44(Apr. 1967). (In Russian).

The resonance level excited at 2322 keV in the $^{26}Mg(p,\gamma)^{27}Al$ reaction was studied in an investigation of high-level excitation states of the ^{27}Al nucleus. The gamma and coincidence spectra were measured. The gamma ray angular distribution enabled the determination of the resonance level spin as well as the possible value of spin at the level with excitation energy of 3.951 MeV. (JPRS)

9805 QUANTUM CHARACTERISTICS OF THE 3.01- AND 2.65-MeV LEVELS IN THE ^{35}Cl NUCLEUS. Kopanets, E. G.; Koval, A. A.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. (Engineering Physics Inst., Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 631-6(Apr. 1967). (In Russian).

Investigations carried out to determine uniquely the quantum characteristics of the 2.65- and 3.01-MeV levels in ^{35}Cl by measuring the $(p\gamma\gamma)$ correlations of the gamma rays emitted in the decay of the resonance state ^{35}Cl decay at $E_{exc} = 8.385$ MeV are reported. An integrating coincidence spectrometer was used to investigate the $(p\gamma\gamma)$ correlation. The $8.4 \rightarrow 3.0$ and $8.5 \rightarrow 2.65 \rightarrow 0$ γ-ray cascades were selected. (JPRS)

9806 STUDIES OF γ RAYS IN INELASTIC PROTON SCATTERING BY ^{34}S NUCLEI. Kopanets, E. G.; Koval, A. A.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. (Engineering Physics Inst., Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 626-30(Apr. 1967). (In Russian).

The γ rays emitted in the $^{34}S(p,p'\gamma)^{34}S$ reaction were studied. The excitation function of this reaction was determined. The angular distribution of γ rays at 2.13 MeV was measured to gather new data on the high levels in ^{35}Cl. The possible values of spin resonances are given for $E_p = 2880$, 2920, 2941, 2955, 3000, 3042, and 3053 keV. (JPRS)

9807 LOW LEVELS OF ^{37}Cl NUCLEI. Ievlev, Yu. P.; Koval, A. A.; Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. (Engineering Physics Inst., Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 645-9(Apr. 1967). (In Russian).

The decay of the 1147-keV resonance state in the $^{36}S(p,\gamma)^{37}Cl$ reaction was investigated. The γ-ray spectrum, coincidence and double correlation were studied for the 1.725 MeV (E_γ = 7.8 MeV), 3.087 (E_γ = 6.5 MeV) and 4.3 MeV (E_γ = 2.5 MeV) levels. A weak transition and 0.838 MeV was observed from the hard γ-ray distribution. (JPRS)

9808 ^{24}Mg(p,t) REACTION AT 50 MeV. Ganguly, N. K. (Rutherford High Energy Lab., Chilton, Eng.); Rush, A. A.; Burge, E. J.; Smith, D. A. Z. Phys., 208: 73-6(1968).

Angular distributions are given for tritons from the ground and first two excited states of the ^{24}Mg(p,t)^{22}Mg reaction. Excitation energies, spins and parities of these levels are given, and a new level is also reported. (auth)

9809 THE ^{27}Al(^{3}He,α)^{26}Al REACTION AT 10-MeV BOMBARDING ENERGY. Nurzynski, J.; Bray, K. H.; Robson, B. A. (Australian National Univ., Canberra). Nucl. Phys., A107: 581-92 (1968).

The reaction ^{27}Al(^{3}He,α)^{26}Al was studied at 10-MeV bombarding energy. Angular distributions were measured for the ground state and the first (0.229 MeV), second (0.418 MeV), third (1.059 MeV), "fourth" (1.760/1.852 MeV), and "sixth" (2.07/2.08 MeV) excited states in ^{26}Al. The spectra were recorded at every 5° between 15 and 165° (lab). The direct-interaction contributions to the cross sections were calculated using the distorted wave Born approximation and are compared with the observations. The effects of both a finite-range interaction and the non-locality of the optical potentials are also considered. For optical-model parameters which describe the related elastic scattering results, an $l = 2$ neutron transfer was found to be most consistent with the data in all cases except for the transitions to the 1.760/1.852-MeV levels, which do not seem to proceed via a direct interaction. Relative spectroscopic factors were determined and are in a good agreement with a simple model in which ^{27}Al and ^{26}Al consist only of $(d_{5/2})^{-1}$ and $(d_{5/2})^{-2}$ configurations. (auth)

9810 REACTION MECHANISM OF THE ^{35}Cl(d,2p)^{35}S GROUND-STATE REACTION AT E_d = 14.5 MeV. Brown, P. F.; Saladin, J. X.; Rollefson, A. A.; Burke, J. A.; Crowley, P. A.; Kerns, J. R. (Univ. of Pittsburgh). Nucl. Phys., A107: 529-44 (1968).

The ^{35}Cl(d,2p)^{35}S g.s. reaction was studied at 14.5-MeV bombarding energy. Coincident protons were detected using solid-state detectors, and their correlated energy spectra were analyzed by a 64 × 64 channel pulse-height analyzer. Measurements were carried out at various angular combinations (θ_1,θ_2). The angular dependence of the differential cross section and the shapes of the energy spectra were compared with the results of some simple model calculations. It was found that at forward angles the reaction proceeds mainly via a direct (d,p) reaction, followed by the evaporation of a proton from the intermediate nucleus, while double evaporation is the dominant process at backward angles. (auth)

9811 THE ^{62}Ni(^{3}He,d)^{63}Cu REACTION AT 11.0 MeV. Smith, D. L.; Chen, H. Y.; Enge, H. A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A107: 639-44(1968). (MIT-2098-381).

A total of 13 levels including four unresolved multiplets in ^{63}Cu below 2.8-MeV excitation energy was excited via the ^{62}Ni(^{3}He,d)^{63}Cu reaction with 11.0-MeV incident energy. Angular distributions were measured for 12 of the deuteron groups. Ten of these distributions were fitted with DWBA curves, and spectroscopic factors (C^2S) were extracted. (auth)

9812 A STUDY OF THE ^{28}Si(p,d)^{27}Si REACTION. Jones, G. D.; Johnson, R. R.; Griffiths, R. J. (Univ. of Colorado, Boulder). Nucl. Phys., A107: 659-70(1968). (COO-535-573).

Angular distributions were obtained for the ^{28}Si(p,d)^{27}Si reaction and the elastic scattering of protons on ^{28}Si at a proton bombarding energy of 27.6 MeV. An optical-model analysis was performed of the elastic scattering results to obtain parameters for a DWBA analysis. Distorted-wave calculations for the direct transitions leading to single-particle states in ^{27}Si were used to extract spectroscopic factors. The spectroscopic factors obtained are compared with the results of ^{28}Si(^{3}He,^{4}He)^{27}Si calculations. (auth)

9813 PARTICLE-HOLE STATES IN ^{40}Ca ACCORDING TO THE SU$_3$ SCHEME. Larner, D.; Williams, S. A. (Ames Lab., Iowa). Nucl. Phys., A107: 354-68(1968). (IS-1624).

The contributions of the one-particle-one-hole excitations to the negative-parity levels of ^{40}Ca are calculated. The basic states are harmonic oscillator states symmetrized according to SU$_3$, and in the process of constructing these states, some Clebsch–Gordan coefficients for the (30) representation are computed. The residual interaction employed is the Kallio–Kolltveit potential, which used the Moszkowski–Scott separation method. The energy matrix is computed directly from the SU$_3$ states, using the projection integral method of Elliott. Nine states are obtained, seven of which may be compared with experimental data on the low-lying states of ^{40}Ca. Five of these states show good agreement with experiment. (auth)

9814 REACTION MECHANISM OF THE ^{35}Cl(d,2α)^{29}Si GROUND-STATE REACTION BETWEEN E_d = 12.0 MeV. Rollefson, A. A.; Saladin, J. X.; Burke, J. A.; Crowley, P. A.; Kerns, J. R. (Univ. of Pittsburgh). Nucl. Phys., A107: 545-51(1968).

The reaction ^{35}Cl(d,2α)^{29}Si g.s. was studied at bombarding energies between 9.0 and 12.0 MeV. Coincident α-particles were detected using solid-state detectors, and their correlated energy spectra were analyzed by a 64 × 64 channel pulse-height analyzer. Measurements were carried out at various angular combinations (θ_1,θ_2). From the shape of the energy spectra as well as from the angular dependence of the differential cross section, it is concluded that the reaction proceeds via a double evaporation process. The shapes of the energy spectra and the dependence of the differential cross section on the bombarding energy are in good agreement with the results of a double evaporation calculation. (auth)

9815 THERMAL NEUTRON CROSS SECTIONS AND RESONANCE INTEGRALS OF ^{64}Zn, ^{74}Se, ^{85}Rb, AND ^{98}Mo. Sims, G. H. E.; Juhnke, D. G. (Atomic Energy of Canada Ltd., Ottawa). J. Inorg. Nucl. Chem., 29: 2853-8(Dec. 1967).

The effective neutron capture cross sections of the isotopes ^{64}Zn, ^{74}Se, ^{85}Rb, and ^{98}Mo were measured by an activation method. By irradiating samples with and without cadmium covers, and by using the Westcott convention, the 2200-m/sec cross sections and the resonance integrals (including the 1/v part) were calculated. The respective values for each isotope are: ^{64}Zn, 0.821 ± 0.011 and 1.34 ± 0.06 barns; ^{74}Se, 66.8 ± 1.4 and 589 ± 12 barns; ^{85}Rb, 0.396 ± 0.005 and 24.7 ± 1.7 barns; ^{98}Mo, 0.137 ± 0.006 and 6.79 ± 0.42 barns. The measurements are relative to a ^{59}Co cross section of 37.5 barns, and quoted errors are at the 95% confidence level. (auth) (UK)

9816 SYSTEMATICS OF ^{24}Na AND ^{22}Na PRODUCTION WITH 400-MeV PROTONS. Korteling, Ralph G.; Caretto, A. A. Jr. (Carnegie Inst. of Tech., Pittsburgh). J. Inorg. Nucl. Chem., 29: 2863-78(Dec. 1967).

Cross sections for the production of ^{24}Na and ^{22}Na were determined with 400-MeV protons on thirty-six target elements having atomic numbers between 12 and 92. Most of the target elements, however, had $Z < 50$. For target elements up to $Z \sim 30$, the cross sections vs atomic number decreased exponentially. Above $Z \sim 30$ the cross sections deviated from this exponential trend and show maxima at atomic numbers of 33 and 45. The exponential decrease of cross section vs target atomic number was compared with calculations based on a simplified version of the cascade-evaporation model. It is possible to show that the cascade-evaporation mechanism predicts this exponential dependence. The structure observed in the cross section for target atomic numbers greater than 30 is considered on the basis of possible fission processes. The origin of this structure is not clearly understood at present. (auth) (UK)

9817 THE FIRST AND SECOND EXCITED STATES OF ^{27}Si. da Silva, C. M.; Lisle, J. C.; da Silva, M. F. (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 92: 107-9(Sept. 1967).

The first and second excited states of ^{27}Si were populated by the reaction ^{28}Si(^{3}He,α)^{27}Si. The particle–gamma ray angular correlation associated with the decay of the first excited state is consistent with $J = 1/2$ for this state. The data on the second excited state are satisfied by $J = 3/2, 7/2$. The decay modes of these states are compared with those of the analogous states in ^{27}Al. (auth)

9818 WEAK GAMMA-RAY TRANSITIONS IN ^{20}Ne. Broude, C.; Litherland, A. E.; Ollerhead, R. W.; Alexander, T. K. (Atomic Energy of Canada Ltd., Chalk River, Ontario). Can. J. Phys., 12: 3837-47(Dec. 1967).

Various techniques were applied to the measurement of weak gamma-ray decay modes of the 4.97-MeV 2^- and 7.02-MeV 4^- states in ^{20}Ne excited by the reaction ^{12}C(^{12}C,$\alpha\gamma$)^{20}Ne. The M2 decay of the 4.97-MeV state to the ground state is 0.6 ± 0.2% of the total level width, corresponding to an M2 width of 2×10^{-3} Weisskopf units. The M2–E3 transition from the 7.02-MeV state to the 1.63-MeV 2^+ state is 0.5% ± 0.2% of the level width; if all M2, this would correspond to an inhibition of 1.4×10^{-2} Weisskopf units, if all E3, to an enhancement of 6 Weisskopf units. The reliability of the measurements was checked by angular correlation measurements of the weak transitions. (auth) (Canada)

9819 ENERGY LEVELS OF Z = 11 to 21 NUCLEI. IV. Endt, P. M.; van der Leun, C. (Univ., Utrecht). Nucl. Phys., A105: 1-488(1967).

A compilation of experimentally determined properties of energy levels of Z = 11 to 21 nuclei is presented with special emphasis on nuclear spectroscopy. (3500 references.) (auth)

9820 COMPENDIUM OF THERMAL-NEUTRON-CAPTURE γ-RAY MEASUREMENTS. PART I. $Z \le 46$. Bartholomew, G. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Doveika, A.; Eastwood, K. M.; Monaro, S.; Groshev, L. V.; Demidov, A. M.; Pelekhov, V. I.; Sokolovskii, L. L. Nucl. Data, Sect. A, 3: 367-650(Dec. 1967).

A compilation is presented of thermal neutron-capture γ-ray energies and intensities with decay schemes, examples of original data, and fully corrected spectral distributions. A table of stable isotopes with abundances, thermal neutron radiative-capture cross sections, spins, parities, and other information of value to neutron-capture γ-ray spectroscopy is included. (auth)

9821 ANGULAR CORRELATION STUDIES IN ^{46}Ti. Lewis, C. W.; Mo, J. N.; Monahan, C. F.; Thomas, M. F.; Twin, P. J. (Univ. of Liverpool). Nucl. Phys., A107: 273-304(1968).

Method 2 of Litherland and Ferguson is used to determine spins and mixing ratios of gamma-ray transitions in ^{46}Ti. The on-line computer data collection system and new data reduction techniques are described. States at 2.951, 3.158, and 3.225 MeV are shown to have spins of 2, 1, and 2, respectively. Probable spin assignments of 5 and 4 are given to the states at 3.430 and 3.048 MeV, respectively. Mixing ratios were determined for the relevant gamma rays from all five states. Branching ratios were measured for the states at 2.951, 3.158, 3.225, 3.430, 3.834, 3.874 and 3.892 MeV. Composite branching ratios were measured for the doublets at 3.57 and 4.02 MeV. Results are compared with the calculations of McCullen, Bayman and Zamick. (auth)

9822 INVESTIGATION OF $J \rightarrow J$ M1 TRANSITIONS IN ^{38}Ar. Engelbertink, G.A.P.; Lindeman, H.; Jacobs, M.J.N. (Univ., Utrecht). Nucl. Phys., A107: 305-31(1968).

The γ-decay of eight ^{37}Cl(p,γ)^{38}Ar resonances in the range E_p = 1.0 to 1.8 MeV was investigated with a 20 cm^3 Ge(Li) detector. Precision γ-ray energy measurements yield the energies of 23 bound states of ^{38}Ar (errors 0.14 to 3.0 keV) and the Q-value of the ^{37}Cl(p,γ)^{38}Ar reaction, Q = 10,242.5 ± 1.1 keV. Mean lifetimes (or lower limits) of 12 bound states were found from measurements of γ-ray Doppler shifts. The spins and parities of levels at E_x = 4.57, 4.88, 5.51, 6.21, 6.60, 6.67, 11.35, and 11.93 MeV were determined as $J^\pi = (2^-), 3^-, 3^{(-)}, 4^-, 4^-, (5^-), 3^-$ and 4^-, respectively, on the basis of γ-ray angular-distribution and polarization measurements and/or intensity considerations. Several γ-ray multipole mixing ratios were obtained. The strong $J^\pi = 4^-$ resonance at E_p = 1732 keV can be regarded as the analogue of the third excited state in ^{38}Cl. The strength of M1 transitions of $J \rightarrow J$ character, up to 0.4−0.6 W.u., is an order of magnitude larger than that of $J \rightarrow J \pm 1$ transitions. (auth)

9823 A STUDY OF THE EXCITED STATES OF ^{31}P WITH THE ^{30}Si(p,γ)^{31}P REACTION. Wolff, A. C.; Meyer, M. A.; Endt, P. M. (Univ., Utrecht). Nucl. Phys., A107: 332-46(1968).

The γ-ray spectra of 46 resonances in the ^{30}Si(p,γ)^{31}P reaction were measured with a 20 cm^3 Ge(Li) detector. Branching ratios of resonances and bound states were determined. Radioactive sources were used for accurate determination of the energies of the bound states and of the reaction Q-value. The latter, Q_0 = 7297.4 ± 1.2 keV, is 10.2 ± 4.0 keV higher than the value from the 1964 mass table. Lifetimes of 13 bound states were obtained from γ-ray Doppler shift measurements. The latter measurements prove that there are two levels at about E_x = 5.0 MeV, with excitation energies differing less than 1 keV. They also yield even parity for the E_x = 4.78 MeV level. (auth)

9824 WIDTH OF THE 3.13 MeV STATE IN ^{31}P. Creten, W. L.; Jacobs, R. J.; Ferdinande, H. M. (Univ., Ghent). Nucl. Phys., A107: 347-53(1968).

The bremsstrahlung spectrum of 3.5 MeV electrons from a linear accelerator was used to excite the 3.13 MeV level of ^{31}P. From a self-absorption experiment the width of this level was determined to be Γ = 49 ± 10 keV. (auth)

9825 ANGULAR CORRELATION STUDIES OF EXCITED STATES IN ^{23}Mg. Blake, R. S.; Paul, E. B.; Sinex, C. H. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Nucl. Phys., A107: 253-65(1968). (ORO-1316-34).

Alpha-gamma angular correlation measurements in the reaction ^{24}Mg(^{3}He,$\alpha\gamma$)^{23}Mg lead to the assignments $J = 5/2, 7/2 \le 5/2, \le 5/2, (3/2, 5/2, 7/2)$ and $\le 5/2$ to the ^{23}Mg levels at 0.45, 2.04, 2.35, 2.78, 3.78, and 4.35 MeV, respectively. The branching ratios of these levels and the mixing ratios of some of the γ-rays are reported. (auth)

9826 RADIATIVE CAPTURE OF THERMAL NEUTRONS BY ^{48}Ti. Carlos, P.; Matuszek, J.; Audias, A.; Maier, B. P.; Nifenecker, H.; Perrin, G.; Samama, R. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A107: 436-48(1968). (In French).

Measurements are reported of $\gamma-\gamma$ coincidence and $\gamma-\gamma$ angular correlation spectra on ^{49}Ti after thermal neutron capture. New cascades were identified, and the spins of the three first excited states in ^{49}Ti were determined. Some relations between the spins of other excited states and between the mixing parameters δ are also given. (auth)

9827 SPEED OF THE $\Delta J = 1, \Delta T = 1$ M1 TRANSITION IN ^{26}Al. Youngblood, D. H. (Argonne National Lab., Ill.); Bearse, R. C.; Williams, N.; Blaugrund, A. E.; Segel, R. E. Phys. Rev., 164: 1370-4(Dec. 20, 1967).

The attenuated-Doppler-shift technique was used to determine the mean life of the 1.059-MeV third excited state in ^{26}Al to be 3.1×10^{-14} sec. The state decays primarily to the $J^\pi = 0^+$, T = 1, 0.229-MeV first excited state. The spin component in this pure M1 transition can be deduced from the analogous Gamow-Teller β decay from the ^{26}Si ground state to the 1.059-MeV state in ^{26}Al. The observed lifetime is only about half what would be predicted from the spin component alone. This indicates a strong orbital contribution which, in turn, implies a large $(d_{5/2})^{-2}$ component in the wave function. A summary of M1 transitions whose spin components are known from analogous β decays is given. A mean life of $4.8 \pm 2.5 \times 10^{-14}$ sec was found for the second excited state of ^{26}Mg. (auth)

9828 STUDY OF THE (d,p) REACTIONS ON $^{64\ 66\ 68\ 70}$Zn. von Ehrenstein, D.; Schiffer, J. P. (Argonne National Lab., Ill.). Phys. Rev., 164: 1374-85(Dec. 20, 1967).

Angular distribution from the (d,p) reactions on ^{64,66,68,70}Zn were measured with 10.0-MeV deuterons from the Argonne Tandem Van de Graaff accelerator. The energies, spins, parities, and spectroscopic factors of levels up to about 3.5-MeV excitation energy were determined by use of distorted-wave Born-approximation calculations. Empirical J-dependence rules are used to distinguish between $3/2^-$ and $1/2^-$ states. The ground-state Q values of the ^{64,66,68,70}Zn (d,p) reactions, determined within ±10 keV, were 5.758, 4.827, 4.259, and 3.609 MeV, respectively. The sums of the spectroscopic factors are discussed briefly. (auth)

9829 PROPERTIES OF SOME LEVELS OF ^{35}Cl. Taras, P.; Oleksiuk, L. W.; Azuma, R. E.; Prentice, J. D. (Univ. of Toronto). Phys. Rev., 164: 1386-96(Dec. 20, 1967).

Angular distributions, triple angular correlations, and polarizations of the γ rays emitted in the reaction ^{34}S(p,γ)^{35}Cl were measured. Three resonances were investigated at proton energies of 1.020, 1.213, and 1.513 MeV. Spin and parity assignments for the 1.220-, 3.006-, 3.163-, 4.174-, 7.358-, 7.544-, and 7.841-MeV levels are discussed. The following spin-parity assignments are deduced: 3.163 MeV, $7/2^-$; 7.358 MeV, $3/2$; 7.544 MeV, $7/2^-$; 7.841 MeV, $3/2$. (auth)

9830 SULFUR PHOTONEUTRON CROSS SECTION. Webb, D. V. (Univ. of Melbourne); Spicer, B. M.; Arenhoevel, H. Phys. Rev., 164: 1397-8(Dec. 20, 1967).

Spicer's shell-model 1p−1h calculation for photoabsorption in ^{32}S indicates that considerable dipole strength should be expected in the regions 3 and 10 MeV above the giant resonance peak. The ^{32}S(γ,n)^{31}S reaction cross section was measured in 250-keV steps from 20 to 32 MeV, and qualitatively confirms these gross predictions. The present cross section was normalized to that reported by Thompson, Taylor, and Webb. To account for the detailed structure that appears in the composite cross section, a calculation was carried out including the coupling of the surface vibration phonons to the 1p−1h dipole states, as described by Drechsel, Seaborn, and Greiner. The calculation increases the number of states carrying appreciable absorption strength, as well as transferring strength to higher energies. The over-all agreement between the theoretical result and the (γ,n) cross section is remarkably good. (auth)

9831 ISOBARIC ANALOG STATES IN ^{35}Cl. Watson, D. D.; Manthuruthil, J. C.; Lee, F. D. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev., 164: 1399-1407 (Dec. 20, 1967).

The γ-ray yield from the ^{34}S(p,γ)^{35}Cl reaction shows strong resonances at proton energies of 1214 and 1512 keV. These resonance states occur at the correct energies to be isobaric analogs of the 1.99- and 2.35-MeV states in ^{35}S, respectively. Angular-distribution, triple-correlation, and polarization measurements were performed at each of these resonances. The 1214-keV resonance, which corresponds to an excitation energy of 7.54 MeV in ^{35}Cl, has spin and parity of $7/2^-$, and decays almost entirely to the

3.16-MeV level, which was also found to have spin and parity of $7/2^-$. The transition is pure M1 and has a measured strength of 1.6 ± 0.3 Weisskopf units (W.u.). The 1512-keV resonance, which corresponds to an excitation energy of 7.84 MeV, has a spin and parity of $3/2^-$, and decays strongly to 4.17-MeV level, which was found to be a $3/2^-$ state. This transition is also pure M1 with a strength of 1.0 ± 0.3 W.u. The value of θ_p^2 is about 0.2 for both the 1214-keV and the 1512-keV resonance, which compares favorably with the value of $\theta_p^2 = 1/3$ calculated for the pure single-nucleon $f_{7/2}$, $T = 3/2$ and $p_{3/2}$, $T = 3/2$ configurations respectively. This agrees with the large (d,p) stripping width of the analog states at 1.99 and 2.35 MeV in ^{36}S. The levels at 3.16 and 4.17 MeV appear to be of the same configuration as the corresponding resonance states, and to differ only in isobaric spin, having $T = 1/2$. Values for the reduced widths, energies, and isobaric-spin splitting of the $T_>$ and $T_<$ states, and for the M1 transition speeds assuming pure single-nucleon states, were calculated and are in good agreement with observed values. (auth)

9832 ENERGY DEPENDENCE OF (p,p′γ) CORRELATIONS IN ^{48}Ti. Hausman, H. J.; Humes, R. M.; Seyler, R. G. (Ohio State Univ., Columbus). Phys. Rev., 164: 1407-18(Dec. 20, 1967).

Absolute double differential cross sections were measured at ten bombarding energies from 4 to 6 MeV for the reaction ^{48}Ti (p,p′γ)0.99 MeV. The angular correlations were measured with the γ-ray detector moving in a plane perpendicular to the reaction plane. Comparisons are made between the measured cross sections and the predictions of the statistical compound-nucleus theory. At all bombarding energies, angular correlations were measured at two supplementary (c.m.) proton-detector angles in order to check the symmetries predicted by statistical theory. Attempts are made to ascribe deviations of the experimental correlations from statistical-model predictions to the presence of direct reactions. The angular dependence of the spin-flip cross section was measured at three bombarding energies: 5.16, 5.25, and 5.46 MeV. In addition, the energy dependence of the spin-flip cross section was measured at a laboratory proton-detector angle of 131°. For that geometry wherein the proton detector is in the backward quadrant, agreement between the measured correlations and statistical-model predictions is very good. (auth)

9833 LEVELS OF ^{42}Ca AND ^{46}Ca AS OBSERVED IN THE ^{40}Ca(t,p) AND ^{44}Ca(t,p) REACTIONS. Williams, David C. (Los Alamos Scientific Lab., N. Mex. Sandia Corp., Albuquerque, N. Mex.); Knight, J. D.; Leland, W. T. Contract W-7405-eng-36. Phys. Rev., 164: 1419-33(Dec. 20, 1967). (LA-DC-8910).

The reactions ^{40}Ca(t,p) and ^{44}Ca(t,p) were studied at a bombarding energy of 7.5 MeV using an E-ΔE solid-state detector telescope with an over-all energy resolution of about 50 keV. A cross-section fluctuation analysis was carried out on the ^{40}Ca(t,p) reaction; it showed that the compound-nucleus process did not contribute significantly to the observed transitions. Twenty-seven excited states in ^{42}Ca and 24 in ^{46}Ca were identified. The principal maxima in the angular distributions of the stronger ^{40}Ca(t,p) transitions were fitted with the predictions of a relatively simple distorted-wave Born-approximation stripping code, and L values were assigned for 16 transitions. These values are in agreement with previously assigned spins and parities in all cases where the latter have been reported. L values were assigned to 12 ^{44}Ca(t,p) transitions. The ratios of cross sections for certain corresponding transitions in the ^{40}Ca(t,p) and ^{44}Ca(t,p) reactions were compared with the theoretical predictions assuming pure ($f_{7/2}^n$) configurations for these states; agreement was found for the ground and the 4+ states, but not for the 2+ states. The strongly excited levels of ^{42}Ca and ^{46}Ca are discussed in terms of shell-model configurations. Evidence is presented for the hypothesis that neutron configurations of the type ($f_{7/2}^{n-1}p_{3/2}$) are not the major components of the wave functions of states in ^{42,44,46}Ca at excitation energies below 4 MeV, in contrast with a number of theoretical treatments of these isotopes which have placed such configurations at energies ≲3 MeV. States involving excitation of the ^{40}Ca core appear to be important. (auth)

9834 INELASTIC-SCATTERING STUDIES WITH POLARIZED PROTONS. Glashausser, C. (Centre d'Etudes Nucleaires, Saclay, France); de Swiniarski, R.; Thirion, J.; Hill, A. D. Phys. Rev., 164: 1437-50(Dec. 20, 1967).

The inelastic scattering of 18.6-MeV polarized protons was studied for the following nuclei: ^{48}Ti, ^{50}Ti, ^{52}Cr, ^{54}Fe, ^{56}Fe, ^{58}Ni, ^{62}Ni, ^{64}Ni, and ^{63}Cu. The targets ^{52}Cr, ^{60}Ni, and ^{62}Ni were investigated at 16.5 MeV. The measured asymmetries for strong $l = 2$ transitions tend to fall into two categories, distinguished by the magnitude of the asymmetries at 30° and 90°. Of those $l = 2$ transitions studied, only those to the first 2^+ state of the 28-neutron nuclei seem to show large asymmetries at these angles. Strong $l = 3$ and $l = 4$ transitions also reveal several interesting variations. When the entire optical potential is deformed, coupled-channels and distorted-wave Born approximation calculations predict the "small" $l = 2$ asymmetries reasonably well, but the fits to the large asymmetries are unsatisfactory. Phenomenological calculations in the spirit of the microscopic model indicate that the predicted asymmetry is sensitive to the form factor. No important differences between $S = 0$ and $S = 1$ predictions were found. Simple calculations with form factors arising from single-particle transitions predict asymmetries which closely resemble those predicted with a real collective-model form factor. (auth)

9835 STUDY OF PROTON PARTICLE-HOLE STATES IN ^{40}Ca BY THE ^{39}K(^{3}He,d)^{40}Ca REACTION. Seth, Kamal K. (Northwestern Univ., Evanston, Ill.); Biggerstaff, J. A.; Miller, P. D.; Satchler, G. R. Contract W-7405-eng-26. Phys. Rev., 164: 1450-74(Dec. 20, 1967). (ORNL-P-3220).

Helium-3-induced charged-particle reactions on ^{39}K were studied using a solid-state-detector dE/dx-E particle-identification telescope. Elastic-scattering angular distributions at ^{3}He energies of 12, 14, and 16 MeV as well as (^{3}He,d) angular distributions at 14 MeV were measured. The reaction data are found to be characterized by extremely weak transitions to all known positive-parity excited states up to 5.3 MeV. Strong transitions to 15 negative-parity states up to 8.6-MeV excitation are observed and identified with the $T = 0$ components of ($d_{3/2}^{-1}f_{7/2}$) and ($d_{3/2}^{-1}p_{3/2,1/2}$) configurations and the $T = 1$ analogs of the ground-state quartet in ^{40}K having the ($d_{3/2}^{-1}f_{7/2}$) configuration. Since the distorted-wave method does not give a unique prescription for choosing between the various possible optical potentials which fit elastic scattering, a detailed examination is made of the effects of the choice specific ^{3}He and deuteron potentials, of the inclusion of spin-orbit coupling and nonlocality, and of the different approximations for the bound-state wave function; and the significance of the spectroscopic factors is discussed. The distorted-wave results are compared with the revised predictions of Gillet and Sanderson, and it is concluded that above and beyond the inherent uncertainties in the spectroscopic factors, Gillet and Sanderson's theoretical predictions agree poorly with the experimental results. (auth)

9836 NUCLEAR STRUCTURE OF ^{22}Na. III. SPINS AND PARITIES FROM THE LINEAR POLARIZATION OF GAMMA RAYS. Poletti, A. R.; Warburton, E. K.; Olness, J. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 164: 1479-84 (Dec. 20, 1967). (BNL-11652).

The linear polarizations of some γ rays resulting from the α bombardment of ^{19}F were measured. From these results, spins and parities of levels in ^{22}Na were assigned or verified as follows: 0.891 MeV ($J^\pi = 4^+$), 1.528 MeV (5^+), 1.937 MeV (1^+), 2.211 MeV (1^-). (auth)

9837 INTERACTIONS OF 1.0-, 2.0-, AND 3-GeV PROTONS WITH Ag AND Br IN NUCLEAR EMULSION. II. Katcoff, Seymour (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-gen-16. Phys. Rev., 164: 1367-9(Dec. 20, 1967). (BNL-11271).

Cross sections for star production and for emission of α particles, light fragments ($3 \le Z \le 6$), and ^{8}Li nuclei are reported for interaction of high-energy protons with the heavy elements in Ilford K.0 nuclear emulsion. These cross sections increase rapidly between 1.0 and 2.0 GeV, and then they level off between 2 and 3 GeV. Those stars which are characterized by two dense tracks in approximately opposite directions have cross sections of 7 ± 2, 30 ± 7, and 50 ± 10 mb at 1.0, 2.0, and 3 GeV, respectively. Arguments are presented which strongly support the idea that the two fragments are of roughly comparable mass and are both mainly in the region $A \approx 15$ to 35 with $Z \approx 7$ to 17. This view is compared with that of Gorichev, Lozhkin, and Perfilov according to which the two fragments are very different in mass, the lighter one being a fragment of $Z = 4$ to 9 and the heavier one a nuclear recoil. (auth)

9838 SPECTROSCOPIC FACTORS FOR PICKUP REACTIONS ON ^{40}Ca. Hubbard, L. B. (Massachusetts Inst. of Tech., Cambridge); Jolly, H. P. Contract AT(30-1)-2098. Phys. Rev., 164: 1434-6(Dec. 20, 1967). (MIT-2098-352).

The spectroscopic factors for the $d_{3/2}$, $s_{1/2}$, and $f_{7/2}$ pickup from ^{40}Ca were calculated in the shell model for two different forces, and the results were compared with distorted-wave Born-approximation (DWBA) analyses of recent experiments. The calculated spectroscopic factors for $f_{7/2}$ pickup were found to be considerably smaller than the DWBA results. Various reasons for this discrepancy are discussed. (auth)

9839 LIFETIMES OF THREE LEVELS IN ^{22}Na MEASURED BY THE DOPPLER SHIFT ATTENUATION IN GASES. Blaugrund, A. E.; Fisher, A.; Schwarzschild, A. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Phys., A107: 411-16 (1968).

Lifetimes of levels at 0.891, 2.210, and 2.572 MeV in ^{22}Na were measured by the Doppler shift attenuation method using C_2F_6 gas as the stopping medium. The lifetimes of the three states are 10.8 ± 1.8, 12 ± 2, and 4.5 ± 1.0 ps, respectively. The states were produced by the (α,n) reaction on ^{19}F near threshold. Gamma rays were detected with a Ge(Li) detector. The applicability of a gaseous stopping medium for attenuated Doppler shift measurements is discussed. (auth)

9840 EXCITED ENERGY LEVELS IN ^{72}Ge. Ottmar, H. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys., 209: 44-59(1968). (In German).

The level structure of ^{72}Ge was investigated using the decay of ^{72}Ga. Measurements of the gamma-ray spectrum were performed by means of a 2.7 cm^2 × 0.2 cm and a 4 cm^2 × 0.5 cm lithium-drifted germanium detector. Coincidence measurements were carried out with two $1\frac{1}{2}'' \varnothing \times 2''$ NaI(Tl) detectors. Fifty-six gamma transitions were observed. A revised level scheme of ^{72}Ge is proposed containing 8 new excited states. (auth)

9841 LEVELS OF ^{44}Ti OBSERVED IN THE REACTION ^{40}Ca(α,γ)^{44}Ti. Vernotte, Jean; Langevin, Michel; Takeutchi, Fujio. (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. A and B, 265: 859-62(Oct. 16, 1967). (In French).

The reaction ^{40}Ca(α,γ)^{44}Ti was studied up to $E_\alpha = 4.3$ MeV. Three resonances are attributed to this reaction, and one resonance is attributed to the interfering reaction ^{16}O(α,γ)^{20}Ne. The spin and parity of the corresponding levels of ^{44}Ti were determined. The first excited state of ^{44}Ti is located at an excitation energy of about 1 MeV. (tr-auth)

9842 AN INVESTIGATION OF FLUCTUATIONS IN TOTAL NEUTRON CROSS SECTIONS IN THE MeV REGION. Carlson, Allan David. Madison, Wis., Univ. of Wisconsin, 1967. 147p.

Thesis.

The total neutron cross sections of Mg, Al, Si, S, Ti, Fe, Co, Zn, Y, Zr, Nb, Ag, Sn, Sb, Pr, Ta, Pb, and Bi were measured with neutron energy spreads of 20 or 50 keV and statistical uncertainties of about 1%. For every element, the neutron energy range from 4.5 to 7.5 MeV was investigated. In some cases larger ranges were studied, the largest was about 10 MeV. No deviations from a smooth energy dependence were observed in the cross sections of the elements Co, Zn, Y, Zr, Nb, Ag, Sn, Sb, Pr and Ta, within the statistical accuracy of the experiment. For the remaining elements, fluctuations were observed in the cross sections, the amplitudes of which decreased with neutron energy. These measurements were made so that information could be obtained about the various types of structure which may be present in neutron total cross sections when there is some overlapping of the compound nucleus levels. The existence of intermediate structure is of particular interest since there is only marginal evidence from previous experiments which indicate the presence of this structure. The cross sections obtained from the investigation were compared with those obtained in previous experiments and optical model calculations. Analyses were performed to determine whether the cross section fluctuations which were observed are consistent with those expected from fluctuations in the spacings and neutron widths of the compound nucleus levels, intermediate structure and Ericson fluctuations. From the analysis relating cross section fluctuations to fluctuations in the spacings and neutron widths of the compound nucleus levels, level densities were obtained which are in reasonable agreement with the calculated values. The agreement is improved if it is assumed that strong level spacing correlations are present. This indicates that the observed fluctuations are consistent with those expected from fluctuations in the neutron widths of the compound nucleus levels. This analysis was also applied to the cross sections which did not exhibit fluctuations. The lack of fluctuations was found to be a result of the high compound nucleus level density. The intermediate structure analysis gave no evidence for the existence of such structure. From the Ericson fluctuation analysis, level densities were obtained which agree with the calculated values at energies which are high enough so that the conditions for the Ericson theory are satisfied. This also indicates that the fluctuations are a result of fluctuations in the neutron widths of the compound nucleus levels. From this analysis, it was possible to obtain the widths of the compound nucleus levels and information pertinent to the average fluctuating cross section for elastic scattering. These quantities are compared with values obtained in earlier experiments. The presence or absence of fluctuations in the cross sections measured in the present experiment can be accounted for entirely by the fluctuations in the neutron widths of the compound nucleus levels. In no case did the data require the assumption of intermediate structure. (Diss. Abstr.)

9843 ENERGY LEVELS OF ^{81}Br POPULATED BY THE DECAY OF ^{81m}Se AND ^{81}Se. Prawirosoehardjo, Soedijono. University Park, Pa., Pennsylvania State Univ., 1966. 96p.

Thesis.

The gamma rays following the decay of ^{81m}Se (57 min) and ^{81}Se (18 min) were investigated using a Ge (Li) detector, a gamma-gamma coincidence apparatus, and a high-pressure gas proportional counter. ^{81m}Se and ^{81}Se were produced by neutron bombardment of 94.4% enriched ^{80}Se and natural selenium. Nine gamma rays were identified as belonging to the decay of ^{81m}Se and ^{81}Se by using the Ge (Li) detector through comparison of spectra taken with enriched ^{80}Se and natural selenium samples, respectively, half-life comparison measurements, and direct half-life measurements. The energies (in keV) and relative intensities (in brackets) of these gamma rays are as follows: ^{81m}Se: 103.3 ± 0.2 (100) and 1146 ± 2 (3.4 ± 0.6). ^{81}Se: 276.3 ± 0.4 (100), 290.2 ± 0.4 (79.6 ± 5.6), 538.7 ± 0.7 (6.2 ± 0.7), 552.7 ± 0.7 (12.8 ± 1.4), 566.1 ± 0.7 (28.9 ± 2.6), 650.4 ± 0.9 (2.6 ± 0.4), and 829.2 ± 0.8 (36.3 ± 2.6). In addition, one gamma ray of energy (180 ± 2) keV (relative intensity = 0.94 ± 0.19) was also attributed to ^{81}Se through gamma-gamma coincidence measurements. On the basis of these results an energy level scheme of ^{81}Br populated by the decay of ^{81m}Se and ^{81}Se was proposed by introducing levels at 276, 566, 650, 815, 829, and 1146 keV. The 1146-keV level is populated by a direct beta decay of ^{81m}Se having a transition intensity of (0.34 ± 0.13)%. The beta-decay transition intensities of ^{81}Se to the ground state and to the 566-, 650-, 815-, and 829-keV levels of ^{81}Br were computed to be 98.8 ± 0.33%, 0.76 ± 0.21%, 0.014 ± 0.006%, 0.042 ± 0.013% and 0.36 ± 0.10%, respectively. (Disser. Abstr.)

9844 MEASUREMENT OF RELATIVE ENERGY POSITIONS AND WIDTHS OF SOME (p,γ) RESONANCES IN ALUMINUM AND SODIUM. Mourad, Walid Gerios. Madison, Wis., Univ. of Wisconsin, 1967. 135p.

Thesis.

The energy positions or ratios of the ^{27}Al(p,γ)^{28}Si resonances at 774, 1316, and 1363 keV were determined to 33, 50, and 50 parts per million, respectively, relative to the resonance at 992 keV taken as a standard with an adopted absolute value of 991.82 ± 0.1 keV. This accuracy was made possible by use of a 90° cylindrical electrostatic analyzer of one meter radius in which the plates were aligned parallel such that the gap between them was kept constant over an 8-mm vertical region to about one wavelength of sodium light for 90% of the length of the analyzer and the regulation of the voltage applied to these plates was improved so that the voltage between them could be held constant to about 30 parts per million. Relative to the same standard in aluminum, the energy positions and the widths of ten ^{23}Na(p,γ)^{24}Mg resonances at 987, 1009, 1010, 1020, 1174, 1282, 1318, 1395, 1416, and 1457 keV were determined. Some evidence for a fine structure in the resonances at 1282 and 1456 keV exists but is not conclusive. In these measurements, the discrete nature of energy losses of the protons in the target was taken into account, and all the data were taken with an energy resolution $E/\Delta E$ of about 10,500. The widths of the broad resonances for which $\Gamma > 500$ eV were determined to an accuracy limited by the strength of the resonance in question. Some of these results are at variance with previously published work. The γ-ray yield of the narrow resonance at 1416 keV was studied both at room temperature and in the neighborhood of 80°K. Its energy ratio relative to the 992-keV resonance in aluminum was determined to 50 parts per million. (Diss. Abstr.)

9845 STUDY OF NUCLEAR COULOMB ENERGY SYSTEMATICS. Matlock, Robert Golden. Boulder, Colo., Univ. of Colorado, 1966. 126p.

Thesis.

By Q-value measurements of (^{3}He,t) and (p,t) nuclear reactions, the nuclear mass excesses (^{12}C mass excess = 0) of ^{22}Mg (−0.36 ± 0.06 MeV), ^{24}Al (−0.05 ± 0.06 MeV), ^{28}P (−7.17 ± 0.06 MeV), ^{36}K (−15.58 ± 0.12 MeV), ^{38}Ca (−22.07 ± 0.06 MeV), and ^{40}Sc (−20.38 ± 0.06 MeV) were determined. These data, in conjunction with known mass values of the other members of the isobaric spin triplets to which these nuclei belong, provide a nearly complete set of T = 1 Coulomb energy differences from A = 22 to 40. The nuclear shell model provides a means of relating these data to the known Coulomb energy differences between the ground states of mirror nuclei up to A = 41. An irregularity in the systematic behavior of the Coulomb energies occurs at A = 40. This irregularity appears to be a consequence of the major shell closure at N = Z = 20. The data are in good agreement with the predictions arising from approximate charge independence of nuclear forces. The overall agreement of these data with isobaric multiplet predictions indicates that unknown nuclear masses can be inferred on the basis of Coulomb energy systematics. (Diss. Abstr.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 8040, 8366, 8367, 9455, 9759, 9794, 9800, 9815, 9816, 9837, 9842, 9921, 9926, 9934, 9973, and 9976–9978.

9846 (CEA-R-3309) CONTRIBUTION A L'ETUDE EXPERIMENTALE DE LA FISSION THERMIQUE DE L'URANIUM 235 DANS LA REGION DES MASSES SYMETRIQUES. (Experimental Study of the Thermal Fission of ^{235}U in the Region of Symmetrical Masses). Ribrag, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 17, 1967. 82p. (In French). Dep.

Thesis. Submitted to Paris Univ., Orsay.

Energy correlation experiments with fission fragments are strongly perturbed, in the symmetric region, by the detection of spurious events caused by the apparatus. It is shown that the measurement of an additional parameter, namely the difference in time-of-flight between the fragments enables one to eliminate these difficulties. An original method of calibration of the time-of-flight set-up is also shown. For thermal fission of ^{235}U, values of mass yields in the symmetric region are found to agree quantitatively with radiochemical values. Moreover, the average total kinetic energy distribution as a function of the pre-neutron-emission masses of the fragments has been calculated. This curve presents in the symmetric region a large dip, the value of which takes on the value 21.2 ± 0.8 MeV. This value is smaller than previously published results. (auth)

9847 (FOA-4-4318-22) PROMPT $\bar{\nu}$ IN NEUTRON-INDUCED FISSION OF ^{239}Pu AND ^{241}Pu. Conde, H.; Hansen, J.; Holmberg, M. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Oct. 1967. 15p. Dep.

The energy dependence of prompt $\bar{\nu}$ was investigated for the neutron-induced fissions of ^{239}Pu and ^{241}Pu. The fission neutron detector was a large liquid scintillator, and $\bar{\nu}$ for the spontaneous fission of ^{252}Cf was used as a standard. The measurements of ^{239}Pu and ^{241}Pu were made at incident neutron energies between 4 and 14.8 MeV and 0.5 and 14.8 MeV, respectively. The best fit of the present data for ^{239}Pu and ^{241}Pu are the lines $\bar{\nu}(E_n) = 2.91 + 0.141\ E_n$ (MeV) and $\bar{\nu}(E_n) = 2.91 + 0.146\ E_n$ (Mev) based on $\bar{\nu} = 3.766$ for ^{252}Cf. (auth)

9848 (INP-569/PL) APPLICATION OF THE SUM-COINCIDENCE METHOD FOR g-FACTOR MEASUREMENTS OF SHORT-LIVED EXCITED NUCLEAR STATES. Bozek, E.; Hyrnkiewicz, A. Z.; Zapalski, G.; Kulessa, R.; Walus, W. (Inst. of Nuclear Physics, Krakow (Poland)). 1967. 7p. Dep.

The application of the sum-coincidence technique in g-factor measurements by the observation of the integral perturbed angular correlation in an oriented magnetic field is discussed. The method described was used for the determination of the g-factor of the 603-keV state in ^{124}Te. (auth)

9849 (INR-798/I/PL) IZMERENIE ABSOLYUTNOI VELICHINY POLYARIZATSII ELEKTRONOV POLUCHENNYKH PRI RASPADE IZOTOPOV: ^{46}Sc, ^{137}Cs, ^{204}Tl. (Absolute Measurement on the Longitudinal Polarization of Beta Rays from Isotopes: ^{46}Sc, ^{137}Cs, and ^{204}Tl). Vil'gel'mi, Z.; Volovskii, I.; Khoinatskii, S.; Korman, A.; Plokhotskii, A. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 13p. (In Russian). Dep.

The longitudinal polarizations of electrons from the beta decay of the isotopes ^{46}Sc, ^{137}Cs, and ^{204}Tl were compared. The degree of polarization was measured by the asymmetry in the electron scattering in a thin gold foil. Longitudinal electron polarization was transformed into transverse polarization by means of crossed electric and magnetic fields. The measurements were carried out for the electrons of energy $E_e = 250$ keV. (auth)

9850 (INR-P-827/VI/PH) FISSION-LIKE DISINTEGRATIONS OF MEDIUM-MASS NUCLEI INDUCED BY HIGH-ENERGY PROTONS. Makowska, E.; Sieminska, J.; Suchorzewska, J. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 34p. Dep.

The analysis of 788 fission-like interactions of the 25-GeV/c protons with Ag and Br nuclei in low-sensitivity emulsion was done. Several possible models which might describe these interactions are analyzed, and a new model is discussed on the assumption that the target nucleus breaks up in an explosion. (auth)

9851 (JINR-P4-3576) E0-PEREKHODY I STRUKTURA 0^+ VOZBUZHDENII V DEFORMIROVANNYKH YADRAKH. (E0-Transitions and the Structure of 0^+ Excitations in Deformed Nuclei). Kuliev, A. A.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 20p. (In Russian). Dep.

The quantities ρ (EO), B(E2) and their ratio for O^+ excitations (different in structure) in deformed nuclei (pairing vibrations, spin-quadrupole excitations and β-vibrations) are investigated. The interference effects of different types of excitations are considered, and experimental data for rare-earth nuclei are analyzed. (auth)

9852 (JINR-P4-3607) TABLITSY VOLNOVYKH FUNKTSII ODNOCHASTICHNYKH SOSTOYANII DEFORMIROVANNYKH YADER REDKOZEMEL'NOI OBLASTI DLYA KONECHNOGO POTENTSIALA S RAZMYTYM KRAEM. (Tables of Wave Functions of One-Particle States of Deformed Nuclei of the Rare-Earth Region for a Finite Diffused Potential). Gareev, F. A.; Ivanova, S. P.; Kalinkin, B. N.; Slepnev, S. K.; Ginzburg, M. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 50p. (In Russian). Dep.

In addition to the previous paper, tables are presented of wave functions of one-particle states of deformed nuclei of the rare-earth region in the approximation of a finite diffused potential. (auth)

9853 (JINR-P6-3605) SPEKTRY α-CHASTITS PRI RASPADE VOZBUZHDENNYKH SOSTOYANII ^{148}Sm SO SPINAMI 3^- I 4^-. (α-Particle Spectra from the Decay of ^{148}Sm Excited States With Spins 3^- and 4^-). Popov, Yu. P.; Stempinskii, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 8p. (In Russian). Dep.

Preliminary results of an investigation of α spectra from the decay of separate highly excited states are given. The influence of the pairing effect of the last neutrons in the nuclei on the value of the reduced α-particle widths in the reaction ^{147}Sm(n,α)^{144}Nd is discussed. (D.C.W.)

9854 (JINR-P7-3613) SVOISTVA IZOTOPOV RADIYA S MASSOVYMI CHISLAMI 214-206. (Properties of Ra Isotopes With Mass Numbers 214 to 206). Lobanov, Yu. V.; Druin, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 6p. (In Russian). Dep.

The $^{214-206}$Ra isotopes were synthesized in the nuclear reactions ^{194}Pt(^{22}Ne,xn)$^{216-x}$Ra and ^{192}Pt(^{22}Ne,xn)$^{214-x}$Ra. The isotopes were identified on the basis of the excitation function. α-particle energies and the half-lives of the $^{214-206}$Ra isotopes were measured. (auth)

9855 (ORO-2843-12) NUCLEAR CHEMISTRY GROUP PROGRESS REPORT, 1967. Muga, M. Louis (Florida Univ., Gainesville). Dec. 1967. Contract AT(40-1)-2843. 23p. Dep. CFSTI.

Thermal neutron-induced ternary fission of ^{239}Pu and ^{233}U was investigated, and a radiochemical search was made for low-mass fission products from thermal neutron-induced fission of ^{235}U. Neutron emission in ternary fission of ^{252}Cf is being investigated in a triple coincidence experiment using a fission chamber. Preliminary measurements were made of the angular distribution of alpha particles from the thermal neutron-induced fission of ^{235}U. A time-of-flight charged-particle detector was developed and was applied to the design of a low-mass fission-fragment time-of-flight mass spectrometer. (D.C.W.)

9856 (UCRL-50332) EXCITATION FUNCTION OF THE REACTIONS ^{147}Sm(d,2n)^{147}Eu BELOW 12 MeV. Read, Jacques B. J. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 27, 1967. Contract W-7405-eng-48. 7p. Dep. CFSTI.

Using a stacked foil technique, the ^{147}Sm(d,2n)^{147}Eu excitation function was determined from 7.6 to 12.0 MeV. Upper limits only were estimated at 5.6 and 6.6 MeV. Over 50 photopeaks were seen in the spectra of the targets. Of these, two were easily resolved at 198 and 602 keV and were due to ^{147}Eu decays. The excitation function indicates the existence of an intermediate structure peak at an incident deuteron energy of 9.5 MeV. (auth)

9857 (UJV-1909) LEVEL STRUCTURE OF ^{193}Ir. Plajner, Z.; Brabec, V.; Maly, L.; Vejs, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Oct. 1967. 33p. Dep.

The decay of ^{193}Os was studied with a 30-cm double-focusing β spectrometer, intermediate-image β spectrometer, lithium-drifted germanium detectors, and $\beta-\gamma$ and $\gamma-\gamma$ coincidence technique. Twenty-seven transitions were found, from which the 41.0-, 65.9-, 96.1-, and 185.5-keV transitions were established for the first time. Two of them, the 41.0- and 65.9-keV transitions, were determined from coincidence information only. Internal conversion, gamma-ray, and gamma-gamma coincidence intensities are given. The multipolarities of some transitions were derived from relative internal conversion coefficients. The present data are consistent with a proposed decay scheme with excited states at 73.05, 138.95, 179.9, 362.3, 440.8, 460.8, 557.6, 559.5, 659.6, and 712 keV. The present decay scheme was analyzed in the light of the Nilsson model. (auth)

9858 ISOMERIC-STATE EXCITATION IN ^{191m}Ir BY ^{116m}In GAMMA RAYS. Abrams, I. A. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 5, 50-1(1967). (In Russian).

A technique for obtaining the isomeric state ^{191m}Ir in the reaction (γ,γ') is described. The half-life as well as the activation profile of ^{191m}Ir and the energies of isomeric transition were determined. (auth)

9859 GAMMA SPECTRA OF ^{237}Np. Vara, J. M.; Gaeta, R.; Dominguez, G. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 381-5(Nov.-Dec. 1967). (In Spanish).

The gamma spectrum of ^{237}Np was obtained with a Ge(Li) detector. A continuous method of separating ^{237}Np from its comparatively short-lived daughter ^{233}Pa was applied; it is described together with the spectra taken during the operation. The results are discussed. (auth)

9860 GAMMA SPECTRA OF ^{233}U. Monleon, J. L.; Gaeta, R. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 387-91(Nov.-Dec. 1967). (In Spanish).

The gamma spectrum from the decay of ^{233}U was studied using a Ge(Li) spectrometer. The improved experimental conditions and a careful radiochemical separation of the decay products permitted the identification of seven previously unreported gamma lines. (auth)

9861 COLLECTIVE LEVELS OF THE TYPE $I^+K = 0^+0$ IN THE ^{164}Er NUCLEUS. Vrzal, Ya.; Gromov, K. Ya.; Liptak, Ya.; Molnar, F.; Morozov, V. A.; Urbanets, Ya.; Chumin, V. G. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 604-25(Apr. 1967). (In Russian).

The spectra of positrons and conversion electrons were studied by means of magnetic spectrometers and spectrographs. The γ-ray spectrum was measured on a scintillation spectrometer, and the γ coincidences were measured on a magnetic β spectrometer. (JPRS)

9862 LEVELS OF ^{165}Dy EXCITED DURING RADIATIVE NEUTRON CAPTURE. Bondarenko, V. A.; Prokof'ev, P. T. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 596-603(Apr. 1967). (In Russian).

The spectra of conversion electrons from ^{165}Dy emitted in the course of the (nγ) reaction on ^{164}Dy are reported. Particular attention was paid to the spectrum above 300 keV. The results are analyzed and compared with the published data. Conversion factors were determined from the conversion electron γ-ray intensity. The multipole orders are assigned to the energy levels of 600, 1103, 1167, and 1591 keV. Qualitative evidence that the 1103 level may be considered to be the Nilsson [512]↑state is given. (JPRS)

9863 THREE-QUASI-PARTICLE LEVELS IN ^{163}Er. Gnatovich, V.; Gromov, K. Ya.; Finger, M.; Vrzal, Ya.; Liptak, Ya.; Urbanets, Ya. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 587-95 (Apr. 1967). (In Russian).

The complete spectrum of γ rays appearing during the decay of ^{163}Tm was measured to determine the multipolarity of rigid γ transitions and quantum characteristics of the levels above 1000 keV. Results are shown in a table. (JPRS)

9864 SIGN OF δ IN ANGULAR $\gamma\gamma$ CORRELATIONS FOR DE-EXCITATION OF ^{172}Yb. Dzhelepov, B. S.; Listengarten, M. A.; Shestopalova, S. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 581-6 (Apr. 1967). (In Russian).

A study was made of the angular correlations for the electron-capture decay $^{172}\text{Lu} \rightarrow {}^{172}\text{Yb}$. The authors are unable to satisfactorily account for the seeming contradiction in determining the sign of δ in the multipole mixture E2 + M1 in the transition $h\nu$ = 1093 keV. (JPRS)

9865 α DECAY OF ^{225}Ac, ^{221}Fr, AND ^{217}At. Dzhelepov, B. S.; Ivanov, R. B.; Mikhailova, M. A.; Moskvin, L. N.; Nazarenko, O. M.; Rodionov, V. F. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 568-80(Apr. 1967). (In Russian).

The α decay of the 4n + 1 family was studied spectroscopically. An earlier paper reported the preparation of isotopes and data on the energies and intensities of α-transitions of ^{225}Ac. Results are reported of further processing of these data and similar data for ^{221}Fr and ^{217}At. The results were found to be in good agreement with the data of G. Graeffe et al. for the decay of ^{221}Fr. However, three α-groups additional to those known were found and attributed (without univocal proof) to ^{221}Fr. A belief is expressed that the number of α-groups in the ^{217}At spectrum is much larger than that reported by Graeffe. Other significant differences, for which no explanation can be advanced, were also found between the work of Graeffe and the present work. (JPRS)

9866 THE MAGNITUDE OF THE REDUCED MAGNETIC DIPOLE TRANSITION PROBABILITIES IN ^{165}Ho. Berson, I. Ya.; Gal'perin, L. N.; Il'yasov, A. Z.; Lemberg, I. Kh. (Ioffe Engineering Physics Inst., Ashkhabad, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 656-9(Apr. 1967). (In Russian).

A p-i-n Ge counter was used to study the Coulomb cascade excitation of rotational levels in ^{165}Ho in the main band under bombardment by N ions at 62 MeV. The experimental values of reduced magnetic dipole transition probabilities are shown to be in agreement with the calculated values if allowance for a 20% error in the measurement of δ is made. (JPRS)

9867 ENERGY LEVEL DIAGRAM FOR ^{151}Pm. Dzhelepov, B. S.; Kalinichev, Yu. V.; Sergeev, A. G. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 670-9(Apr. 1967). (In Russian).

The hard gamma-ray spectrum from the β decay of ^{151}Nd was studied in order to resolve uncertainties in the literature regarding the ^{151}Pm energy level diagram. In addition, a comparison was made of the ^{153}Eu and ^{155}Eu nuclei to gather additional information on the ^{151}Pm levels. It was found that a number of ^{151}Pm levels can be regarded as single particle Nilsson states with associated rotational levels. The structure of these levels is similar to those of ^{153}Eu and ^{155}Eu. (JPRS)

9868 LARGE SPIN ROTATIONAL LEVELS IN EVEN–EVEN $_{54}$Xe, $_{56}$Ba, AND $_{58}$Ce ISOTOPES. Peker, L. K. (Mendeleev Scientific Research Inst. of Metrology, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 683-7(Apr. 1967). (In Russian).

The ground state of nuclei with $Z \leq 76$ as indicated by the value of E_4^+/E_2^+ is considered on the basis of literature data, and similar considerations are extended to the deformation region Z, N = 56 to 74. It is concluded that the ground states of $^{120-130}$Xe, ^{134}Ce, and the adjacent isotopes are spherical and that the $I^\pi = 4^+$ states are rotational. (JPRS)

9869 DECAY OF ^{106}Rh. Vrzal, Ya.; Grigor'ev, E. P.; Zolotavin, A. V.; Liptak, Ya.; Sergeev, V. O.; Urbanets, Ya. (Leningrad State Univ. Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 696-9 (Apr. 1967). (In Russian).

^{106}Rh with the 1^+ characteristics was investigated using 30-sec ^{106}Rh in equilibrium with the parent ^{106}Rh with $T_{½}$ = 366 days. The internal conversion electron and gamma spectra were measured. The energies and relative intensities of gamma transitions in ^{106}Pd are tabulated. (JPRS)

9870 DECAY OF ^{245}Pu. Daniels, W. R.; Hoffman, D. C.; Lawrence, F. O.; Orth, C. J. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., A107: 569-80(1968). (LA-DC-9067).

The radiations associated with the β decay of 10.5 h ^{245}Pu were studied with Ge(Li) and Si(Li) detectors, a xenon-filled proportional counter and conventional NaI(Tl) scintillators used in singles and coincidence configurations. The β spectrum is complex with a 1210 ± 40-keV end-point energy. The most intense group has a 930 ± 30 keV end-point energy. Conversion-electron lines of the more intense γ transitions were measured, and tentative multipolarities were assigned. A total of 70 γ rays was observed in Ge(Li) single spectra, and most of these transitions were included in the ^{245}Am level scheme, which includes excited states at 19, 28, 47, 70, 87, 124, 134, 327, 396, 475, 757, 796, 887, 920, 958, 988, 1066, 1112, and 1185 keV. The present data are consistent with spin and parity assignments of $^9/_2{}^-$ for ^{245}Pu and $^5/_2{}^+$ for ^{245}Am. The total β disintegration energy of ^{245}Pu is 1.26 ± 0.03 MeV. (auth)

9871 THE DECAY OF ^{251}Cf. Chetham-Strode, A. Jr.; Silva, R. J.; Tarrant, J. R.; Williams, I. R. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A107: 645-54(1968).

The α-particle and γ-ray single-channel and coincidence spectra of ^{251}Cf were obtained using Si(Au), Ge(Li), and NaI(Tl) detectors. A total of 14 groups was identified with α-particle energies (in MeV) and absolute intensities (in %): 6.067(2.7), 6.007(12.3), 5.932(0.5), 5.844 (27.8), 5.808(4.1), 5.792(2.8), 5.757(3.9), 5.721 (1.1), 5.667(34.7), 5.640(2.8), 5.625(4.8), 5.595(0.5), 5.559(1.8) and 5.496(0.3). At least three rotational bands based upon single-particle levels at 0, 227 and 407 keV excitation energy were identified. The half-life of the 227-keV state was measured to be 25 μsec. (auth)

9872 INELASTIC SCATTERING OF FAST NEUTRONS FROM ^{197}Au. Barnard, E.; de Villiers, J. A. M.; Engelbrecht, C. A.; Reitmann, D. (South African Atomic Energy Board, Pelindaba). Nucl. Phys., A107: 612-23(1968).

A 3-MeV Van de Graaff accelerator together with a fast neutron time-of-flight spectrometer was used to study the inelastic scattering of neutrons from ^{197}Au for incident energies up to 1500 keV. The inelastic neutron scattering cross sections were determined at 90° from about 100 keV above the respective thresholds for the known levels in gold as well as for a number of previously unknown levels. An attempt was made to determine the energies of the excited states and assign spins and parities to the different levels. It appears that neutron excitation provides information on nuclear structure not readily attainable by other means. (auth)

9873 STUDY OF THE INTERNAL BREMSSTRAHLUNG OF ^{32}P AND ^{90}Y (ANGULAR CORRELATION AND SPECTRUM). Kreische, W.; Lampert, W.; Loos, G. (Univ., Erlangen, Ger.). Nucl. Phys., A107: 601-11(1968). (In German).

The internal bremsstrahlung of ^{32}P and ^{90}Y is studied with various methods of measurement. The measurement of the energy spectrum and the integral angular correlation of ^{32}P and the measurement of the differential energy spectrum of ^{90}Y at angles $\Theta = 22.5$, 30, 45 and 90° are described. The experimental results are compared both with the experimental results of other authors and with theoretical calculations. (auth)

9874 THERMAL-NEUTRON CAPTURE CROSS SECTION OF CADMIUM. Meadows, J. W. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 31: 152-3(Jan. 1968).

The thermal neutron capture cross section of Cd was previously measured using the pulsed-source technique. An analysis of the data in terms of currently available information on the resonance parameters of Cd and the diffusion cooling coefficient of H_2O is outlined. (D.C.W.)

9875 FORMATION OF ^{24}Na IN THE INTERACTION OF 12-GeV PROTONS WITH ISOTOPES OF URANIUM AND LEAD. Juliano, A.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). J. Inorg. Nucl. Chem., 29: 2859-62(Dec. 1967).

Separated ^{233}U, ^{235}U, ^{238}U, and ^{208}Pb isotopes were bombarded with 11.6-GeV protons and the cross sections for the production of ^{24}Na determined as 12.3 ± 0.6 mbarn, 12.0 ± 1.0 mbarn, 12.5 ± 2.5 mbarn, and 8.3 ± 0.6 mbarn, respectively. It is concluded that the cross section for the formation of ^{24}Na from heavy elements is a function of the atomic number of the target, but not of its composition. (auth) (UK)

9876 NEUTRON ABSORPTION CROSS SECTION OF ^{237}U. Cornman, W. R.; Hennelly, E. J.; Banick, C. J. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Sci. Eng., 31: 149-52(Jan. 1968). (DP-MS-67-11).

The neutron absorption cross section of ^{237}U was measured by irradiating two samples of U_3O_8 in the Savannah River High-Flux Reactor at time-averaged fluxes of 1.77 and 2.41×10^{15} n/cm^2 sec, respectively, and counting the ^{237}Np that resulted from the decay of the ^{237}U formed. The ^{237}U cross section was determined from the ratio of ^{237}Np in the two samples. (D.C.W.)

9877 EMISSION OF DELAYED NEUTRONS IN THE FISSION OF ^{238}U, ^{232}Th, AND ^{209}Bi INDUCED BY 156-MeV PROTONS. Gauvin, H.; Sauvage, L. (Institut de Physique Nucleaire, Orsay, France). J. Inorg. Nucl. Chem., 29: 2839-51(Dec. 1967). (In French).

Half-lives, relative abundances, and absolute yields of delayed neutrons were measured for the three nuclides. For uranium and thorium, periods and relative abundance values were similar to those observed for low energy fission. This result is interpreted as the participation of a low-deposition-energy fission process in the high-energy proton-induced fission. The yield of delayed neutrons from bismuth fission is very low, in qualitative agreement with the expected production of neutron-rich products in fission. Attempts are made to compare the experimental yields of delayed neutron groups with possible precursor yields deduced from charge dispersion curves. The emission probability of delayed neutrons is estimated for ^{87}Br, ^{88}Br, and ^{137}I, and new precursors are suggested. (auth) (UK)

9878 FOURNARY FISSION OF ^{235}U NUCLEI INDUCED BY THERMAL NEUTRONS. Benisz, J.; Panek, T. (Higher Pedagogical Coll., Katowice, Poland). Acta Phys. Pol., 32: 673-5 (1967).

The existence of fournary fission of ^{235}U induced by thermal neutrons and 2.5-MeV neutrons was reported by E. W. Titterton (Phys. Rev., 83: 1076(1951)). The same author also observed fournary fission of ^{232}Th and ^{238}U induced by gamma rays. Fournary fission of ^{235}U induced by 23 MeV gamma rays was observed by F. K. Goward et al. (Nature, 164: 661(1949)). They determined two heavy fragments and two α particles for events of fournary fission. Goward et al. suggested that α particles were emitted from ^{8}Be. ^{8}Be as a fragment of ternary fission of the nucleus was emitted. In this experiment, the existence of fournary fission of ^{235}U induced by thermal neutrons was investigated; and the total kinetic energy release in fournary fission of ^{235}U was determined. The nuclear emulsion technique was used for the detection of fournary fission fragments. Nuclear plates were loaded with natural uranium. (auth)

9879 ON THE SPIN OF THE 413-keV STATE IN ^{147}Pm. Kumar, N. Rana; Lakshminarayana, V. (Andhra Univ., India). Curr. Sci. (India), 37: 2-3(Jan. 5, 1968).

The spin of the 413-keV level in ^{147}Pm was investigated by recording fast-slow sum-coincidence spectra from the decay of ^{147}Nd with angles of 90, 135, and 180° between the detectors. A polynomial fit to the spectral peaks was made; the correlation coefficients were corrected for finite detector size. The results favor a spin assignment of $^3/_2$ for the 413-keV state. (D.C.W.)

9880 NEW ISOTOPES, ^{176}Re AND ^{175}Re. Nadjakov, E.; Nenov, N.; Hristov, D.; Pfrepper, G.; Zaitseva, N. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Compt. Rend. Acad. Bulg. Sci., 20: 533-5(1967).

The isotopes ^{176}Re and ^{175}Re were obtained from irradiation of a Ho target with ^{16}O ions and a Tb target with ^{22}Ne ions. They were identified by using their genetic relation with daughter W and Ta, and also by observing rotational levels of ^{176}W known from reactions. The half-lives were found to be ^{176}Re : 5 ± 1 min and ^{175}Re : 5 ± 1 min. (auth)

9881 MIXING FROM DIFFERENT PRINCIPAL HARMONIC OSCILLATOR SHELLS IN Gd, Dy, AND Er NUCLEI. Sheline, R. K.; Bennett, M. J.; Dawson, J. W.; Shida, Y. (Florida State Univ., Tallahassee). Phys. Lett., 26B: 14-16(Dec. 11, 1967).

The intensity systematics of a series of states strongly populated in the (d,t) reaction in 91, 93, 95, and 97 neutron species in Gd, Dy, and Er nuclei, as well as other information, require considerable mixing of the $3^+/2[651]$ and $3^+/2[402]$ orbitals. In the case of ^{155}Gd this $\Delta N = 2$ mixing of states from different principal hormonic-oscillator shells results in a splitting of 162 keV between the two $3^+/2$ states. This splitting is much larger than that predicted by the Nilsson model. (auth)

9882 THE PROTON DECAY OF THE $g_{9/2}$ ANALOGUE RESONANCE IN ^{209}Bi. Richard, P.; Weitkamp, W. G.; Wharton, W.; Wieman, H.; Von Brentano, P. (Univ. of Washington, Seattle). Phys. Lett., 26B: 8-10(Dec. 11, 1967).

Angular distributions to 18 states in ^{208}Pb populated by the reaction ^{208}Pb(p,p′)^{208}Pb were measured at an incident energy corresponding to the $g_{9/2}$ resonance in ^{209}Bi. Total inelastic widths are extracted, and some tentative spin assignments are made. (auth)

9883 EXCITED LEVELS OF ^{132}La. Gerschel, Claudie (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. A and B, 265: 508-9(Aug. 21, 1967). (In French).

The existence of Ge detectors has made it possible to study the decay of ^{132}Ce. A energy level scheme is proposed for ^{132}La. (tr-auth)

9884 THE DECAY HALF-LIFE OF ^{163}Yb. Paris, Pierre (CNRS, Orsay, France). Compt. Rend., Ser. A and B, 265: 510-11(Aug. 21, 1967). (In French).

The decay ^{163}Yb → ^{163}Tm was observed for the first time. The determination of the decay of several isotopically separated sources made it possible to attribute to ^{163}Yb a half-life of $T_{1/2} = 10.9 \pm 0.5$ min. (tr-auth)

9885 CONTRIBUTION TO THE STUDY OF THE DECAY SCHEME OF ^{134}Cs. Legrand, Jean; Boulanger, Jean-Pierre (CEA, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 782-4(Oct. 2, 1967). (In French).

The energies and intensities of the γ transitions of ^{134}Ba emitted as a result of the decay of ^{134}Cs were determined using a γ spectrometer with a Ge–Li semiconductor. The energies and intensities found are tabulated. (tr-auth)

9886 THE HIGH-ENERGY γ RADIATION OF ^{214}Bi (Ra C). Maria, Henriette; Ardisson, Gerard (Faculte des Sciences, Nice). Compt. Rend., Ser. A and B, 265: 789-92(Oct. 2, 1967). (In French).

The γ radiation of ^{214}Bi was studied with a pair spectrometer using a n-i-p Ge diode as the central detector. The energy and relative intensity of 55 γ rays above 1 MeV were measured. (tr-auth)

9887 DENSITY FUNCTIONS S_0 AND S_1 OF THE NUCLEUS OF ^{209}Bi. Morgenstern, Joseph; de Barros, Solange; Chevillon, Pierre-Louis; Huynh, Vinh-Dinh; Jackson, Harold; Julien, Jean; Samour, Claude (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. A and B, 265: 506-7(Aug. 21, 1967). (In French).

The density functions s and p of ^{209}Bi were measured in the energy region from 0 to 70 keV. The existence of an intermediate structure is discussed. (tr-auth)

9888 THE REACTION ^{209}Bi(t,α)^{208}Pb. Bjerregaard, J. H. (Univ. of Copenhagen); Hansen, Ole; Nathan, O.; Chapman, R.; Hinds, S. Nucl. Phys., A107: 241-52(1968).

The reaction ^{209}Bi(t,α)^{208}Pb was investigated using the Aldermaston 13 MeV triton beam, and the reaction products were momentum analyzed and detected in the multi-angle, magnetic spectrograph. A total of 21 α-particle groups was observed to ^{208}Pb states below 5.7 MeV excitation energy. For the states below 4 MeV, the measured angular distributions were compared with DWBA predictions and relative spectroscopic factors were deduced. The data were compared with the results of RPA calculations for particle-hole states in ^{208}Pb performed by Gillet et al. and by Kuo et al. The comprehensive calculations of Kuo et al. successfully reproduce the gross features of the experimental results as well as the essential details for the excited states below 4 MeV. (auth)

9889 ACTIVATION CROSS SECTIONS OF N = 82 ISOTONES FOR 14-MeV NEUTRONS. Cuzzocrea, P.; Notarrigo, S.; Perillo, E. (Istituto Nazionale di Fisica Nucleare, Naples. Univ., Naples) Nuovo Cim. (10), 52B: 476-81(Dec. 11, 1967).

Reaction cross-sections were measured for some rare-earth nuclei, i.e., ^{138}Ba, ^{139}La, ^{140}Ce, ^{141}Pr, ^{142}Nd(n,p); ^{138}Ba, ^{140}Ce, ^{141}Pr, ^{142}Nd, ^{144}Sm(n,2n); ^{138}Ba(n,α); ^{138}Ba, ^{139}La, ^{141}Pr(n,γ) by activation with 14.0 ± 0.2-MeV neutrons. The results were compared with the predictions of approximate formulas based on the statistical model, and a good agreement was found. (auth)

9890 COLLECTIVE VIBRATIONAL STATES IN EVEN ERBIUM NUCLEI. Tjoem, P. O.; Elbek, B. (Univ. of Copenhagen). Nucl. Phys., A107: 385-401(1968).

The cross sections for inelastic scattering of 12 MeV deutrons from all the even Er isotopes were measured at 90° and 125° by means of a magnetic spectrograph. The $2^{+\prime}$ and $4^{+\prime}$ states in the gamma vibrational bands were observed in all nuclei, but only in a few cases the K = 0 β-vibrations were observed. Several octupole vibrational states were identified in each nucleus below an excitation energy of approximately 2.3 MeV. The reduced transition probabilities B(E2) and B(E3) were determined from the observed inelastic cross sections. (auth)

9891 DECAY OF ^{144}Pr TO LEVELS IN ^{144}Nd. Raman, Subramanian (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Phys., A107: 402-10(1968). (ORNL-P-3444).

The γ-rays from ^{144}Pr were measured with a 6 cm^3 Ge(Li) detector. Nine γ-rays were observed. Gamma-gamma coincidence and angular correlation measurements were performed with the Ge(Li) detector and a NaI(Tl) scintillation detector. It is proposed that ^{144}Pr decay populated levels in ^{144}Nd at 1510, 1560, and 2085 keV in addition to the previously known levels at 0, 696.3, and 2185.6 keV. Angular correlation measurements show that the spin of the 2085 level is 0. The half-life of ^{144}Pr is 17.3 ± 0.1 min. (auth)

9892 DECAY OF ^{109}Cd. East, Larry V. (Air Force Weapons Lab., Kirtland AFB, N. Mex.); Murphy, Harry M. Jr.; Lewis, Edwin R. Nucl. Phys., A107: 382-4(1968).

The decay of ^{109}Cd was followed for a period of 220 d by observing the 88 keV gamma transition with a Ge(Li) spectrometer. The half-life of ^{109}Cd was found to be 459 ± 6 d. The energy of the gamma ray resulting from the transition was found to be 87.9 ± 0.2 keV. (auth)

9893 DECAY SCHEMES OF 42 min ^{123}Sn AND 10 min ^{125m}Sn. Baedecker, P. A.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. Nucl. Phys., A107: 449-66(1968). (MIT-905-104).

The radioactive decay schemes of 42 min ^{123}Sn and 10 min ^{125m}Sn were studied with the aid of a Ge(Li) detector and coincidence equipment. Levels in ^{123}Sb at 160, 542, and 712 keV were populated in the decay of 42 min ^{123}Sn and levels at 332, 643, 921, 1349, 1484, 1700, 1736, 1914, 1947, and 2112 were populated in ^{123}Sb in the decay of 10 min ^{125m}Sn. The systematic behavior of low-lying levels of odd-mass Sb isotopes is discussed, and the levels observed in this study are compared to the levels calculated by Kisslinger and Sorensen. (auth)

9894 PROPERTIES OF THE LOW-ENERGY EXCITED STATES IN ^{125}I AND ^{127}I. Kownacki, J.; Ludziejewski, J.; Moszynski, M. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Phys., A107: 476-80(1968).

The half-lives of the excited states in ^{125}I and ^{127}I were measured with a time-to-amplitude converter. The reduced transition probabilities B(M1) and B(E2) were established, and the results were compared with the predictions of the single-particle model as well as with the "pairing-plus-quadrupole-force" model used by Kisslinger and Sorensen for spherical nuclei. (auth)

9895 CONVERSION ELECTRONS OF ^{188}Re FOLLOWING NEUTRON CAPTURE. Suarez, A. A. (Technische Hochschule, Munich); von Egidy, T.; Kaiser, W.; Mahlein, H. F.; Jones, A. Nucl. Phys., A107: 417-26(1968).

Conversion electrons of ^{188}Re following neutron capture in ^{187}Re were measured with the beta spectrometer at the FRM reactor. In the energy range between 8 keV and 300 keV, 53 conversion lines were found. Multipolarities were determined for 39 transitions. A level scheme containing 11 levels with spins and parities is proposed. (auth)

9896 DECAY OF ^{172}Tm. Otteson, O. H. (Utah State Univ., Logan); Helmer, R. G. Phys. Rev., 164: 1485-94(Dec. 20, 1967).

The decay of $^{172}_{69}$Tm to $^{172}_{70}$Yb was studied with lithium-drifted germanium detectors used to obtain singles and coincidence spectra. A multiparameter analyzer was used for coincidence measurements. The measurements indicate the presence of 49 γ-ray transitions for which energies and intensities were obtained. The level scheme proposed for ^{172}Yb has states with energies, spins, and parities of 0.0(0$^+$), 78.70(2$^+$), 260.2(4$^+$), 1043(0$^+$), 1119(2$^+$), 1172.3(3$^+$), 1262.9(4$^+$), 1375.8(5$^+$), 1466.0(2$^+$), 1476.8(1$^-$), 1549.2 (3$^+$), 1608.6(2$^+$), 1662.6(3$^+$), 1700.6(3$^+$), 1750.0(4$^+$), and 1806(4$^+$) keV. The states at 1043 and 1119 keV form a $K^\pi = 0^+$ rotational band of which the most likely interpretation is a pairing vibration. The data concerning the levels at 1172.3, 1262.9, and 1375.8 keV are consistent with their previous interpretation as members of a $K^\pi = 3^+$ rotational band. A $K^\pi = 2^+$ band with levels at 1466.0 and 1549.2 keV is interpreted as being, at least predominantly, a γ-vibrational band. It is suggested that the 1476.8-keV level may be a $K^\pi = 0^-$ octupole vibrational state. The level at 1608.6 keV is interpreted as a two-neutron state with $K^\pi = 2^+$ and with possible rotational levels at 1700.6 and 1806 keV. (auth)

9897 DECAY OF ^{193}Os TO ^{193}Ir. Agin, G. P.; Clark, G. E.; Mandeville, C. E.; Potnis, V. R. (Kansas State Univ., Manhattan). Phys. Rev., 164: 1495-1502(Dec. 20, 1967).

The energies and relative intensities of the γ rays of ^{193}Os ($T_{1/2}$ = 32 h) were measured with a Ge(Li) detector. γ-γ coincidences and β-γ coincidences were studied to obtain energies of nuclear states in ^{193}Ir. In all 24 detected γ transitions were ordered between 11 nuclear energy states. The energies of these transitions are 73, 98, 107, 139, 180, 219, 252, 281, 289, 299, 322, 362, 379, 388, 420, 438, 461, 486, 512, 532, 559, 574, 713, and 874 keV, establishing excited energy states at 73, 139, 180, 362, 438, 461, 559, 680, 713, and 874 keV in the nucleus of ^{193}Ir γ rays corresponding to transition energies of 618, 780, and 830 keV were also observed, but these transitions could not be suitably incorporated into the disintegration scheme. (auth)

9898 NUCLEAR LEVEL STRUCTURE OF ^{151}Nd. Nealy, Carson L.; Sheline, R. K. (Florida State Univ., Tallahassee). Contract AT(40-1)-2434. Phys. Rev., 164: 1503-8(Dec. 20, 1967).

Forty-nine states in ^{151}Nd were observed between the ground state and 2208 keV utilizing 10-MeV deuterons and the reaction ^{150}Nd(d,p)^{151}Nd. The ground-state Q value for this reaction was measured to be 3084 ± 15 keV. Absolute cross sections of the proton groups were measured, and angular distributions allowed the determination of l values for eight of these groups. The interpretation of the experimental results was based upon the energy systematics in a deformed nucleus and the relative strengths of the (d,p) transitions in a deformed odd-A nucleus. Levels are assigned as belonging to the $\frac{5}{2}-[523]$, $\frac{3}{2}-[521]$, $\frac{1}{2}-[530]$, and $\frac{1}{2}-[521]$ rotational bands. The $\frac{1}{2}-[521]$ rotational band is shown to be appreciably mixed with the K-2 γ-vibrational bands built on the $\frac{5}{2}-[523]$ and $\frac{3}{2}-[521]$ bands. The comparison between the differing ground-state Nilsson orbitals in ^{151}Nd, ^{153}Sm, and ^{155}Gd suggests increasing deformation in this sequence. (auth)

9899 PROMPT NEUTRON EMISSION FROM ^{235}U FISSION FRAGMENTS. Maslin, E. E.; Rodgers, A. L.; Core, W. G. F. (United Kindgom Atomic Energy Authority, Aldermaston, Eng.). Phys. Rev., 164: 1520-7(Dec. 20, 1967).

A description is given of measurements of the prompt neutron emission from fission fragments of ^{235}U in thermal neutron induced fission. A beam of neutrons from the AWRE research reactor HERALD induces fissions in a thin (20 μg/cm^2) sample of ^{235}U. Neutrons are detected in a large (250 liters) liquid-scintillation counter and the fragment kinetic energies are measured with gold-silicon surface-barrier counters. Distributions, showing the neutron emission from both individual fission fragments and pairs of fragments, are given as functions of both the mass of the fragment and the total kinetic energy of the pair. (auth)

9900 FISSION OF URANIUM AND TANTALUM INDUCED BY 156-MeV PROTONS. Stephan, Claude J. (Institut de Physique Nucleare, Orsay, France); Perlman, Morris L. Phys. Rev., 164: 1528-36(Dec. 20, 1967). (BNL-11661).

Measurements on the fission of U and Ta induced by 156-MeV protons were made with semiconductor detectors for the fission fragments. Information concerning the following quantities was obtained: fission cross section of Ta; fission probability for Ta and U as a function of angle between the fission fragments; single-fragment and fragment-pair kinetic energy spectra as a function of angle between fragments in the case of U; and kinetic energy spectra integrated over all angles between fragments, in the case of Ta. The results are interpreted in terms of the cascade-evaporation model, and some comparisons with the liquid-drop-fission calculations are presented. (auth)

9901 DECAY OF ^{253}Fm. Ahmad, I.; Friedman, A. M.; Barnes, R. F.; Sjoblom, R. K.; Milsted, J.; Fields, P. R. (Argonne National Lab., Ill.). Phys. Rev., 164: 1537-44(Dec. 20, 1967).

The decay scheme of ^{253}Fm was investigated by α-particle, γ-ray, and electron spectroscopy. Eleven α groups were observed with energies and intensities 7.092(1.3%), 7.032(6.7%), 6.952(42.7%), 6.910(9.8%), ~6.876(~0.9%), 6.855(8.4%), 6.682(23.2%), 6.659(2.4%), 6.639(2.6%), 6.550(1.5%), and ~6.496 MeV (~0.3%). Two γ rays of energy 144.8 and 271.8 keV were identified and their multipolarities were determined to be M2 and E2, respectively. The excited state at 144.8 keV was assigned as $^5/_2$+ (622↑) and the half-life of this level was measured to be 45 μsec. The level at 416.6 keV is identified as the $^1/_2$+ (620↑) state. The energy levels of ^{249}Cf and the α transition probabilities to them seem to be in agreement with the current theories. (auth)

9902 GAMMA RAYS FROM THE ^{199}Hg(n,γ)^{200}Hg REACTION AND ENERGY LEVELS IN ^{200}Hg. Schult, O. W. B.; Kane, W. R.; Mariscotti, M. A. J.; Simic, J. M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 164: 1548-58(Dec. 20, 1967).

Gamma-radiation from slow-neutron capture in ^{199}Hg was measured in the energy region from 150 to 8040 keV with a Ge(Li) spectrometer at the Brookhaven graphite reactor. The γ energies were obtained with an accuracy varying between 0.10 keV for intense transitions and 3.0 keV for very weak transitions. γ radiation from resonance neutron capture was measured between 5240 and 8040 keV. Altogether, 32 excited states in ^{200}Hg are established, and their modes of decay are given. The lowest five levels have properties which are more complex than those predicted by the vibrational model. The neutron separation energy of ^{200}Hg was determined as 8028.8 ± 0.5 keV. The neutron separation energy of ^{202}Hg is 7755.1 ± 1.5 keV. (auth)

9903 NEUTRON PARTICLE HOLE STRUCTURE IN ^{208}Pb. Moore, C. Fred (Univ. of Texas, Austin); Kulleck, J. G.; von Brentano, Peter; Rickey, Frank. Phys. Rev., 164: 1559-66 (Dec. 20, 1967).

The ^{208}Pb(p,p′) reaction was studied at twelve energies between 14 and 18 MeV, using a magnetic spectrograph placed at 90°. Excitation energies of states in ^{208}Pb were measured up to 7 MeV. Spectra taken on analog resonances in ^{209}Bi exhibit many preferentially populated particle-hole states in ^{208}Pb. Qualitative information about the structure of these states is given. (auth)

9904 ELECTRON LONGITUDINAL DEPOLARIZATION WITH GREAT ENERGY LOSS. Braicovich, L.; De Michelis, B.; Fasana, A. (Istituto di Fisica del Politecnico, Milan. Gruppo Nazionale di Struttura della Materia del Consiglio Nazionale delle Ricerche, Milan). Phys. Rev., 164: 1360-6(Dec. 20, 1967).

The average longitudinal depolarization of β particles of ^{90}Sr + ^{90}Y, which have lost a great fraction (up to 70%) of their energy in aluminum, was measured in the energy ranges 0.35 to 1.1, 0.35 to 2.2, and 0.9 to 2.2 MeV. The results are discussed with reference to different theoretical pictures of the depolarization process; the results agree, within the errors, with the depolarizations calculated on the basis of the theory given by Braicovich. (auth)

9905 SHORT-LIVED ISOMERS OF ^{99}Nb AND ^{100}Nb. Huebenthal, Karlheinz; Monnand, Edouard; Moussa, Andre. (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. A and B, 265: 579-82(Aug. 28, 1967). (In French).

Two isomers of Nb produced in the irradiation of ^{100}Mo by neutrons at 14 MeV were detected. The 2.5-sec ^{100}Nb decays by emission of β irradiation with a maximum energy of 4 ± 0.5 MeV and of γ rays with energies of 157, 360, 400, 533, and 598 keV. The 9-sec ^{99}Nb decays by emission of β radiation and of γ radiation with energies of 98 and 140 keV. (tr-auth)

9906 CONTRIBUTION TO THE STUDY OF THE DECAY SCHEME OF ^{110m}Ag. Legrand, Jean; Boulanger, Jean-Pierre (CEA, Essonne, France). Compt. Rend., Ser. A and B, 265: 697-700(Sept. 18, 1967). (In French).

The energies and intensities of the γ transitions of ^{110}Cd associated with the decay of ^{110m}Ag were determined using a Ge(Li) γ spectrometer and approximate methods of calculation (generation of γ spectra beginning with a library of monoenergetic spectra). The existence of a transition of 1.562 MeV is confirmed. (tr-auth)

9907 DIVISION OF NUCLEAR CHARGE IN THE THERMAL NEUTRON FISSION OF ^{235}U. Reisdorf, W. (Technische Hochschule, Munich). Z. Phys., 209: 77-92(1968).

The mean primary nuclear charges of fragments from thermal neutron fission of ^{235}U as a function of initial mass in the range 88 to 105 were determined from the K-ray energy spectra of the light fragments. K-rays were registered with an argon-methane filled proportional counter in coincidence with the pulses from a pair of semiconductor detectors for complementary fission fragments. The deviation of the mean primary charge of the fragments from the "unchanged charge density" value as compared to the density of the parent nucleus ^{236}U was found to be 0.54 ± 0.14 charge units independent of mass in the range 88 to 105. No closed shell effect on the mean primary charge was found. Within about 10^{-9} sec after fission a K x-ray yield of 0.057 ± 0.012 per fission in the light fragment group was measured. The yields are nearly independent of mass in the range 88 to 95 corresponding to a value of 0.04 per fragment and increase up to 0.09 in the mass range 95 to 104, the relative accuracy being 3 to 4%. (auth)

9908 ISOMER SHIFTS OF THE 81-keV γ LINE OF ^{133}Cs. Henning, W.; Quitmann, D.; Steichele, E.; Huefner, S.; Kienle, P. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 209: 33-43(1968). (In German).

Isomer shifts of the 81.0-keV γ transition in ^{133}Cs were measured by the Mössbauer technique for eight ionic Cs compounds, and for the intermetallic compound CsBi$_2$. The source was ^{133}Ba in CaF$_2$. The shifts, relative to CsCl, range from -1.4×10^{-8} eV for CsNO$_3$ to $+1.6 \times 10^{-8}$ eV for CsBi$_2$. The difference in electron density at the Cs nucleus between CsBi$_2$ and CsNO$_3$ is discussed using chemical bonding arguments. For the Cs halides, this difference is estimated from the overlap of outer electron shells in the lattices. A relative change of the mean square charge radius $\delta\langle r^2\rangle/\langle r^2\rangle = +2 \times 10^{-4}$ is derived. (auth)

9909 LEVELS OF ^{221}Fr OBSERVED STARTING WITH ^{225}Ac. Bastin-Scoffier, Genevieve (CNRS, Orsay, France). Compt. Rend., Ser. A and B, 265: 863-5(Oct. 16, 1967). (In French).

The alpha decay of ^{225}Ac, studied by magnetic spectrography, gives for ^{221}Fr 25 levels between 0 and 650 keV, of which several have not been previously observed. (tr-auth)

9910 INTENSITIES AND ENERGIES OF γ RAYS IN THE REACTION ^{89}Y(n,γ)^{90}Y. Irigaray, Jean-Leon (CEN, Gradignan, France. Faculte des Sciences, Bordeaux); Petit, Georges-Yves; Samama, Roland; Maier, Berndt; Carlos, Pierre; Nifenecker, Herve. Compt. Rend., Ser. A and B, 265: 701-4(Sept. 18, 1967). (In French).

The separation energy of the neutron in ^{90}Y was determined, and a scheme of the energy excitation levels of this nucleus was proposed. The de-excitation of the capture level is explained well by attributing spin 1 and negative parity to this level. The first excited states are in agreement with a coupling between the last proton and last neutron in the shell model. (tr-auth)

9911 DECAY SCHEME OF ^{129}Cs. Tschanz, John Frederick. Columbus, Ohio, Ohio State Univ., 1967. 154p.

Thesis.

The level structure of ^{129}Xe formed in the decay of ^{129}Cs which was produced by the bombardment of CaI$_2$ with approximately 24-MeV alpha particles was studied using NaI scintillation detectors for gamma-ray coincidence and angular correlation measurements, an "orange" magnetic spectrometer for measurement of the internal conversion electron spectrum, and a Ge(Li) solid-state detector for gamma-ray energy and intensity measurements. The half-life of the ^{129}Cs ground state, determined from two series of scintillation counter spectra over periods of four and five days, is 32.82 ± 0.10 hours. The energies and intensities of the gamma-ray transitions in ^{129}Xe were found generally to agree with previous values. The intensity ratio of the 411-keV gamma ray to the 371-keV gamma ray, for which previous investigators had reported conflicting values, was determined to be 72.2 ± 1.8 : 1.00. Gamma-ray lines at 491 keV, 623 keV, and 863 keV, appeared in Ge(Li)-detector spectra in addition to a line at 511 keV which was identified as positron annihilation radiation from 180° scintillation counter coincidences. From the intensity of the 511-keV line, it was determined that positron emission occurs in 0.012 ± 0.002% of the ^{129}Cs decays, which indicates that the decay energy for ^{129}Cs is approximately 1350 keV. Scintillation counter coincidence measurements showed a line at about 630 keV in coincidence with gamma-rays of about 280 keV and 320 keV, leading to the conclusion that the 623-keV line in the Ge(Li) spectra is a transition between the 944-keV and the 317-keV levels. Both the 491-keV and the 863-keV gamma rays can be accounted for as transitions from a new level in ^{129}Xe at 903 keV to lower levels at 411 keV and 40 keV, respectively. The half-life of the 40-keV level in ^{129}Xe was measured by obtaining the delayed-coincidence curve for 371-keV gamma rays and XeK x rays. The interpretation of the observed centroid shift of the delayed-coincidence curve with respect to a prompt coincidence curve (1.12 ± 0.15 nsec) is uncertain, since the lifetimes of both the 40-keV and the 411-keV levels contribute to the delayed coincidence curve of the radiations chosen. The life-time of the 317-keV level, also measured by delayed coincidences, is <1 nsec. Internal conversion coefficients, obtained by use of the orange magnetic spectrometer through the normalized K-conversion peak to gamma peak method, were found for the transitions at 177, 278, 317, 411 and 548 keV. The measured conversion coefficients were all consistent with mixed M1-E2 transitions, but because the theoretical M1 and E2 coefficients are so nearly the same, mixing ratios could not be determined. Angular correlation coefficients for gamma-ray cascades were determined. Some special experimental considerations were involved in the angular correlation measurements since the peaks in the scintillation counter spectrum were largely unresolved. The A_4 coefficients are all small, as expected from the previously determined electron capture branching ratios to the ^{129}Xe levels which show the spins of the levels to be $\frac{1}{2}$ or $\frac{3}{2}$. The measured angular correlation coefficients are consistent with spin assignments of $\frac{3}{2}^+$ for the 317-keV level and, for zero or small E2 transition admixtures, $\frac{1}{2}^+$ for the 411-keV level and $\frac{3}{2}^+$ for the 588-keV level. The ^{129}Xe level scheme based on the results of the present experimental work is compared with the level scheme calculated by Kisslinger and Sorensen for a model of spherical nuclei with residual pairing-plus-quadrupole interactions. The calculated and the experimental level schemes are not in good agreement, perhaps because the collective part of the interactions is actually stronger than is included in the calculations. (Diss. Abstr.)

9912 THERMAL NEUTRON CAPTURE GAMMA RAYS FROM ^{170}Tm. Mehta, Kishor Kalidas. College Park, Md., Univ. of Maryland, 1967. 107p.

Thesis.

A single nuclear model for heavy nuclei has not been developed. To provide data which might assist in further formulations, it was decided to measure capture gamma rays from a rare earth element of high neutron cross section. ^{169}Tm was chosen as the target material for a beam of about 5 × 10^4 neutrons per cm^2 per sec from the modified graphite thermal column of the 10 kw swimming pool type University of Maryland Reactor (UMR). About 6 grams of thulium metal and several grams of thulium oxide (Tm_2O_3) in lucite target holders were used. Boron, as Boral sheet, was a collimator material to reduce stray capture gamma rays. To measure the separation energy of the last neutron (S_n) in ^{170}Tm and to identify its various energy levels, both single and coincidence gamma-ray spectra were collected. Two 3-in. × 3-in. sodium iodide, activated with thallium, scintillation crystals and a Technical Measurement Corporation (TMC) 1024-channel analyzer served as the detecting arrangement. A fast-slow Cosmic multiple coincidence unit in conjunction with Victoreen DD2 amplifiers was employed for the coincidence experiments. From the ^{169}Tm(n_{th},γ) single spectrum, a value of 6.54 ± 0.03 MeV is assigned to S_n for ^{170}Tm which compares favorably with Groshev's value of 6.56 ± 0.02 measured by a magnetic Compton spectrometer. Recently, Motz showed this value of S_n to be low by about 35 keV, since ground-state E1 transition is highly forbidden; an attempt was made to explain this inhibition of the transition on the basis of the collective model. Single spectrum showed low-energy gamma-ray peaks at 0.478, 0.65, 0.73, 0.89, 1.2, 1.74, and 2.225 MeV. Gamma-ray spectra in coincidence with a few of these gamma rays and others were collected. For example, several gamma rays, viz., 0.51(strong), 0.59(strong), 0.65(3.5), 0.73(2.4), 0.81(2.0), 0.89(7.0), 0.99(weak), 1.04(6.5), 1.12(weak), 1.22(3.8), 1.28(2.0), 1.4(2.2), 1.6(2.9), 1.7(7.9), 1.92(5.5), 2.37(weak), 2.58(2.5), and 3.18(3.1) were observed in coincidence with 1.2-MeV gamma ray; the number in parenthesis gives the counts per one hour under the full-energy peak. Study of these results indicates presence of 11 new energy levels of ^{170}Tm at 1.90, 2.11, 2.64, 2.88, 3.01, 3.11, 3.29, 3.61, 3.99, 4.30, and 4.50 MeV. It also confirms the existence of the six low-lying (below 1.68 MeV) energy levels identified by Groshev et al., from their single spectra data. The number of energy levels of ^{170}Tm below the neutron capture energy level agrees well with that predicted by the value of the multiplicity. 107 pages. (Diss. Abstr.)

9913 NUCLEAR g-FACTORS OF THE FIRST EXCITED STATES IN ^{152}Sm, ^{154}Sm, ^{156}Gd, ^{158}Gd, AND ^{160}Gd. Wolfe, Paul Jay. Cleveland, Ohio, Case Inst. of Tech., 1966. 168p.

Thesis.

The nuclear g-factors of the first excited rotational states in ^{152}Sm, ^{154}Sm, ^{156}Gd, ^{158}Gd, and ^{160}Gd were measured using the pulsed-beam technique. The precession of the Coulomb-excited nuclei in an external magnetic field was detected by observing the de-excitation gamma radiation as a function of time. The measured g-factors and mean lives (τ) were g = 0.277 ± 0.028 and τ = 2.12 ± 0.06 ns for ^{152}Sm, g = 0.287 ± 0.029 and τ = 4.37 ± 0.13 ns for ^{154}Sm, g = 0.296 ± 0.018 and τ = 3.29 ± 0.08 ns for ^{156}Gd, g = 0.292 ± 0.026 and τ = 3.69 ± 0.09 ns for ^{158}Gd, and g = 0.303 ± 0.026 and τ = 3.92 ± 0.09 ns for ^{160}Gd. Samarium and gadolinium ions are paramagnetic and the magnetic field at the nucleus is altered by the effects of the electron shell. For ^{152}Sm the effective g-factor was measured as a function of temperature to test the accuracy of internal-field calculations. There were significant deviations from the calculated internal field above room temperature. The samarium-metal targets were noticeably perturbed by electric quadrupole interactions. The gadolinium targets were liquid metals and no perturbations were observed. (Diss. Abstr.)

9914 NUCLEAR STRUCTURE STUDIES IN THE TIN ISOTOPES WITH (d,p), (d,t), AND (p,p') REACTIONS. Schneid, Edward Joseph. Pittsburgh, Univ. of Pittsburgh, 1966. 161p.

Thesis.

The energy levels of the odd isotopes up to ~4 MeV excitation energy are studied using the (d,p) and (d,t) reactions. Several new l = 2 states are identified as well as several l = 1 and l = 3 states belonging to the 82-126 neutron shell. The $\frac{7}{2}^+$ state is not identified in ^{123}Sn and ^{125}Sn. Spectroscopic factors for most of the levels are obtained with the aid of distorted-wave Born approximation (DWBA) calculation. A renormalization of the DWBA absolute cross sections is performed to eliminate systematic inconsistencies in the sum of $U_j^2 + V_j^2$. The factors of renormalization are found to be within the well known uncertainties of the DWBA calculations. The values of relative single-particle energies ($\epsilon_j - \epsilon_{\frac{1}{2}}$) are calculated both from the occupation numbers (U_j^2 or V_j^2) and from the single quasiparticle energies (E_j) using pairing theory. The results are in disagreement by as much as 1 MeV or more. From the reactions on the odd isotopes, spin and parity information is obtained for many states in ^{114}Sn, ^{116}Sn, ^{118}Sn, and ^{120}Sn. A comparison is made between experimental spectroscopic factors and theoretically predicted spectroscopic factors. The isobaric analogues of the $\frac{1}{2}^+$ and $\frac{3}{2}^+$ single quasiparticle states of ^{117}Sn, ^{123}Sn and ^{125}Sn are studied using the (p,p') reactions. Excitation functions are taken at 135° and 165° for the excited states of ^{116}Sn, ^{122}Sn and ^{124}Sn. Angular distributions are measured for the strongly excited states at the resonance energies in order to determine the total resonance cross sections. The sums of the inelastic partial widths are determined at each isobaric analogue resonance and a comparison is made between the experimental sum of inelastic partial widths with the theoretically predicted values. The agreement between experiment and theory is found to be reasonable for the (d,p), (d,t) and (p,p') reactions. In the latter case, due to uncertainties in the method of comparison, the agreement is more qualitative than quantitative. (Diss. Abstr.)

9915 X-RAY ENERGIES, EMISSION TIMES, AND YIELD OF ^{252}Cf FISSION; CHARGE DISTRIBUTION OF ^{252}Cf FISSION FRAGMENTS. Dolce, Sanders Robert. New Brunswick, N. J., Rutgers–The State University, 1967. 219p.

Experiments were performed in which x rays coincident with spontaneous fission of ^{252}Cf were observed. By measuring the energies of both fragments from each of many binary fission events, one is able to determine the mass of each of the fragments. Simultaneous measurement of the energies of K x rays coincident with these fragments enables one to construct a K x-ray spectrum for each fragment mass group. From these spectra one is able to extract the yield of K x rays as a function of fragment mass. One is also able to calculate the average K x-ray energy for each fragment mass group, and from these to obtain the average charge associated with each fragment mass using known data relating K x-ray energy to nuclear charge. Such measurements were made using diffused silicon semiconductor detectors to measure fission fragment energies, and using a 1 mm thick NaI(Tl) crystal for K x-ray detection in one case, and a 4 inch diameter proportional counter filled with three atmospheres of argon in another. The results of these measurements indicate that the average nuclear charge as a function of initial fragment mass is consistent with the postulate of maximum energy release. The yield of K x rays per fission was found to be 0.15 for K x rays emitted by light fission fragments, and 0.47 for K x rays emitted by heavy fragments for a total of 0.62 K x rays per fission. Measurements of a similar nature were made using the proportional counter in order to determine the yield of L x rays per fission as a function of fragment mass. The shape of the resulting L x-ray yield per fission curve was found to be quite similar to that of K x-ray yield per fission. Finally, measurements were made of the yield of K x rays coincident with fission as a function of time following fission. Time-of-flight techniques were employed for these measurements; a thin sodium iodide crystal was permitted to view only selected segments of fragment flight through a 0.7 mm collimator. Least squares fits to the resulting yield versus time data indicate that 44% of the light fragments may be assigned a half life of 1.53 nsec., and that 42% of the fragments have half lives shorter than this value, and 14% have half lives longer than this value. Fifty percent of the heavy fragments were found to have half lives of 1.57 nsec.; 37% of the fragments had half lives shorter, and 13% had half lives longer than 1.57 nsec. An average time of emission of K x rays from the fragments was calculated for each of the fragment mass groups. It was found that half lives for K x-ray emission decrease as mass division becomes either very asymmetric or very symmetric. The number of K-shell vacancies per fission, as calculated from the experimental yield per fission of K x rays, shows a marked decrease for final fragment masses greater than mass 153, a region in which one would expect the fragment nuclei to possess large stable nuclear deformation and consequently to have many low energy, highly converted transitions with half lives characteristic of deformed nuclei. The reasons for a decrease in both the number of K-shell vacancies, and of half lives for K x-ray emission, both of which are suggestive of an effective decrease in nuclear deformation, are not understood. Finally, it is suggested that the values one obtains for average nuclear charge as a function of fragment mass are quite sensitive to the times during which ^{252}Cf fission fragments are observed. (Diss. Abstr.)

Nuclear Theory

Refer also to abstracts 9111, 9116, 9436, 9557, 9655, 9759, 9776, 9793, 9800, 9813, 9838, 9845, 9848, 9852, and 9881.

9916 (AERE-M-1956) SUBROUTINE HEITLER. Foderaro, A. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1967. 20p. Dep. CFSTI. UK 3s. 6d.

The subroutine HEITLER computes the Compton, photoelectric, pair-production, and total microscopic cross sections for any element in the range of atomic numbers from 1 to 94 inclusive, and for any photon energy in the range 10 keV to 20 MeV inclusive. It also computes either the Compton absorption cross section or the Klein–Nishina differential scattering cross section, as desired. The Compton cross sections are computed theoretically. The photoelectric and pair-production cross sections are obtained by suitable interpolation in atomic number and energy using a compilation of 25 sets (more or less) of measured cross sections. (auth)

9917 (CALT-63-60) INTERNAL CONVERSION TABLES. PART I. K,L,M-SHELL CONVERSION COEFFICIENTS. Hager, R. S.; Seltzer, E. C. (California Inst. of Tech., Pasadena). June 1967. Contract AT(04-3)-63. 160p. Dep. CFSTI.

Calculations of K-, L-, and M-shell conversion coefficients were performed for nuclei with Z from 30 to 103 taking into account the four lowest electric and magnetic multipoles. The energies of the continuum electron ranged from 1 to 1500 keV for the K shell, from 1 to 1000 keV for the L shell, and from 1 to 500 keV for the M shell. The coefficients are presented as a function of the continuum electron energy, the continuum electron momentum, and the gamma-ray transition energy. (D.C.W.)

9918 (CEA-R-3305) CONTRIBUTION A L'ETUDE DES REACTIONS (d,p) A BASSE ENERGIE SUR NOYAUX LEGERS. (Contribution to the Study of Low-Energy (d,p) REACTIONS ON LIGHT NUCLEI. Nguyen Van Sen (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 20, 1967. 88p. (In French). Dep.

Thesis. Submitted to Grenoble Univ., France.

The analysis of (d,p) reactions at energies <3 MeV using the plane-wave, distorted-wave, and Coulomb-wave Born approximations was investigated; and the results were applied to some experimental data on the ^{9}Be(d,p)^{10}Be, ^{22}Ne(d,p)^{23}Ne, ^{14}N(d,p)^{15}N, and ^{16}O(d,p)^{17}O reactions that indicated a direct mechanism. The first three reactions were treated as stripping, while the ^{16}O(d,p)^{17}O reaction was treated in terms of interference between stripping and compound-nucleus formation. (D.C.W.)

9919 (IPNO/TH-102) THEORY OF N-BODY NUCLEAR REACTIONS AND APPLICATION TO FOUR BODY PROBLEMS. Ballot, J. L.; Becker, F. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). [1967]. 36p. Dep.

A theory of nuclear reactions based on a second-quantization formalism is used to derive the different equations for the N-body direct nuclear reactions. Then, setting $N = 4$ the integral equations for the 4-body problem are explicitly given for (D-D), (T-N) and (^{3}He–N) elastic and inelastic scattering. (auth)

9920 (JINR-P4-3568) VYSOKOENERGETICHESKOE PRIBLIZHENIE V RASSEYANII CHASTITS NA YADRAKH. (High-Energy Approximation in Scattering of Particles on Nuclei). Pol, Yu. S.; Luk'yanov, V. K.; Petkov, I. Zh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 18p. (In Russian). Dep.

The Dirac equation with the optical potential $\overline{V} = V + iW$ is solved in the high-energy approximation ($|\overline{V}|/E \ll 1$). Using the functions found the scattering amplitudes are constructed and the differential cross sections are calculated both for small $\nu < (kR)^{-1}$, and for large $\nu < (kR)^{-1}$ scattering angles. In particular, when the absorption is not considered ($W = 0$), and the particle mass is neglected ($M \ll E$), known results are obtained for the scattering of electrons on nuclei. The corresponding formulas are also obtained for the nonrelativistic case in which $|V| \ll E_{kin.} \ll M$. (auth)

9921 (JUL-CONF-1) DISKUSSIONSTAGUNG UEBER NEUTRONENPHYSIK AN FORSCHUNGSREAKTOREN. VOM 25.–28. APRIL 1967 IN DER KERNFORSCHUNGSANLAGE JUELICH. Vortragskurzfassungen. (Discussion Meeting on Neutron Physics of Research Reactors, April 25–28, 1967 at Juelich Nuclear Research Center. Summaries of Contributions). (Kernforschungsanlage, Juelich (West Germany)). May 1967. 241p. (In German). Dep.

A number of experimental and theoretical studies of neutron absorption, capture, diffraction analysis, fission, and spectrometry are summarized. Developments in neutron spectrometers are briefly described. (D.C.W.)

9922 (NAA-SR-Memo-12489) A TECHNIQUE FOR COMPUTING THE INVERSE DIFFERENTIAL CROSS-SECTION TRANSFORMATION MATRIX T^{-1}. Berland, R. F. (Atomics International, Canoga Park, Calif.). July 28, 1967. Contract AT (04-3)-701. 15p. Dep. CFSTI.

A technique is presented for computing the inverse differential cross-section transformation matrix T^{-1} directly (also the T matrix itself). Some numerical examples are given to demonstrate the accuracy attained. (auth)

9923 (NAA-SR-Memo-12530) NEARREX II: A CODE FOR COMPOUND NUCLEUS CALCULATIONS. Dunford, C. L. (Atomics International, Canoga Park, Calif.). Oct. 5, 1967. 14p. Dep. CFSTI.

Compound-nucleus theory is used to analyze the decay of the compound nucleus by such a means as neutron emission, proton emission, fission, etc. Compound-nucleus formation cross sections as well as neutron transmission coefficients are calculated from the optical model. This information combined with capture and fission model parameters serves as input for a statistical theory of the compound nucleus. The computer program NEARREX which performs calculations based on this statistical model has been converted for use on the IBM 360-50, and considerable modifications have been made to meet project requirements. (auth)

9924 (NP-17186) JAARVERSLAGEN, 1966. (Progress Report [on Materials and Nuclear Physics, Annual], 1966). (Stichting voor Fundamenteel Onderzoek der Materie, Utrecht. Stichting Instituut voor Kernphysisch Onderzoek, Amsterdam (Netherlands)). 1966. 179p. (In Dutch). Dep.

The structure and financing of the Foundation for Fundamental Research on Matter and the Foundation for Nuclear Physics Research are described. The studies of the two Foundations on nuclear physics, mass separation and analysis, metals, molecular physics, solid state physics, thermonuclear reactions, and high energy physics are briefly outlined. Bibliographic data are given for the published works in each division. (J.S.R.)

9925 (STI/PUB-145) FUNDAMENTALS IN NUCLEAR THEORY. Proceedings Series. Lectures Presented at an International Course, Trieste, 3 October–16 December 1966. De-Shalit, A.; Villi, C. (eds.). (International Atomic Energy Agency, Vienna (Austria)). Aug. 1967. 921p. IAEA: $16.00; Austrian S 414.-; Pound 5.13.0; F Fr 78.40; DM 64.-.

Separate abstracts were prepared for the 17 chapters which deal with phenomenological nuclear physics, theoretical nuclear physics, and neutron spectroscopy. (D.C.W.)

For abstracts of individual chapters see: 9935–9951.

9926 (ANL-Trans-548) SIMPLE QUASICLASSICAL CORRELATION FOR THE ANGULAR ANISOTROPY OF NUCLEAR FISSION BY NEUTRONS. Nesterov, V. G.; Smirenkin, G. N.; Tishin, A. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from report FEI-66. 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

An analysis is made of the disagreement between quantum-mechanical calculations of the angular anisotropy of nuclear fission by neutrons and the well-known quasiclassical formula by Halpern and Strutinskii $A = 5\ E_n/8\ K_0^2$. A simple semiempirical correlation is derived for the mean square of the angular moment of the nucleus which eliminates this discrepancy. (auth)

9927 ISOBARIC SPIN: ITS INFLUENCE ON RESEARCH IN NUCLEAR PHYSICS WITH SMALL ACCELERATORS. Harris, Gale I. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Res. Rev. (Office Aerosp. Res.), 6: No. 8, 20-5(Aug. 1967).

The isobaric-spin formalism and its consequences are briefly reviewed, together with some experimental observations on isobaric analog states. The information on nuclear interactions and structure that can be obtained by studying isobaric analog states is also discussed, including the role of small accelerators in such studies. (D.C.W.)

9928 FUNCTION TABLES FOR DETERMINING THE β^+ DECAY PROBABILITIES. II. FORBIDDEN TRANSITIONS. Suslov, Yu. P. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 688-95(Apr. 1967). (In Russian).

Tables of the FN_0, FM_0, FL_1, FM_1, and Fl_2 functions necessary in the analysis of positron β spectra in the first- and second-forbidden transitions are given. The finite nuclear size and the screening action of the nuclear shell were taken into account in the calculations. (JPRS)

9929 OPTIMIZATION OF PHENOMENOLOGICAL PARAMETERS OF EFFECTIVE INTERACTIONS IN THE NUCLEAR SPECTRA PROBLEM. Bukat, G. M.; Poltavskaya, N. A. (Leningrad Engineering Physics Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 680-2(Apr. 1967). (In Russian).

The limited problem of improving the accuracy of the α parameter for which approximate values α^0 are known is considered within the framework of the Migdal phenomenological theory of the nucleus. (JPRS)

9930 SIMPLE METHOD FOR DETERMINING EFFECTIVE EXTERNAL FIELDS IN SUPERFLUID ATOMIC NUCLEI. Birbrair, B. L. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 663-9 (Apr. 1967). (In Russian).

The Migdal–Larkin system of equations from the finite Fermi system theory is used as the starting point in a mathematical consideration of a simple method for determining effective external fields in superfluid nuclei. The static aspect of the effective external fields in magnetic and quadrupole moments, isotope shift, and gamma and beta transition probabilities is also considered. (JPRS)

9931 EFFECT OF CORE EXCITATION ON THE ENERGY SPECTRA OF PAIRS OF NUCLEI. Bukat, G. M. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 660-2(Apr. 1967). (In Russian).

An equation for the excitation energy of the nuclei differing by two nucleons from the nuclei with double magic number in the Migdal theory of finite Fermi systems is used as the basis for a mathematical consideration of the effect of core excitation on the energy spectra of pairs of nuclei. It is concluded that the effect does not depend on the effective interaction sign, and that its influence is greatest on the lower levels of pair nuclei. (JPRS)

9932 SPIN–QUADRUPOLE FORCES AND COLLECTIVE STATES OF DEFORMED NUCLEI. I. 0^+ STATE. Zheleznova, K. M.; Pyatov, N. I.; Chernei, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 550-67(Apr. 1967). (In Russian).

The effect of spin–quadrupole interactions on the properties of collective 0^+ states is considered. An approximate second quantization method is used in simultaneous treatment of long-range quadrupole and spin–quadrupole interactions in deformed nuclei. The computed energies, transition probabilities and wave functions of the 0^+ state in nuclei at $150 \leq A \leq 147$ are given. It is concluded that the effects of spin–quadrupole interactions can apparently be observed in direct nuclear reactions and in alpha and beta decay. (JPRS)

9933 USE OF OPTICAL NUCLEAR MODEL FOR INVESTIGATING DEUTERON AND α-PARTICLE SCATTERING BY NUCLEI. Nemets, O. F.; Rudchik, A. T.; Sokolov, L. S.; Tokarevskii, V. V.; Chernov, I. P. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 532-49(Apr. 1967). (In Russian).

The adequacy of the optical model to describe the interactions of complex particles with a generalized nuclear potential is considered. Deuteron and α-particle interactions are discussed in an illustration that the optical model indeed gives a good formal description of the experimental facts, though it does not solve the difficulty of selecting the most realistic potential from a multiplicity of satisfactory solutions. (JPRS)

9934 NONROTATIONAL STATES OF ODD DEFORMED NUCLEI IN THE $155 \leq A \leq 181$ REGION. Solov'ev, V. G.; Fogel, P.; Yungklaussen, G. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 518-31(Apr. 1967). (In Russian).

The energies and structures are given for the ground and excited states of a number of odd deformed nuclei (Gd, Er, Dy, Yb, Hf, Eu, Ho, Tm, and Lu isotopes) in the $155 \leq A \leq 181$ region. The characteristics for all computed states at excitation energies up to 1 MeV are given for all the nuclei investigated, and some data for energies >1 MeV is included. A secular equation determining the η_j energies of the ground and excited state was used. (JPRS)

9935 PHENOMENOLOGICAL DESCRIPTION OF NUCLEAR SCATTERING AND DIRECT INTERACTIONS. Frahn, W. E. (Univ. of Cape Town, S. Africa). pp 3-91 of STI/PUB-145.

A survey of the phenomenological approach to the description of direct nuclear reactions and scattering is presented. The complex-potential (optical) model and the strong absorption model are described together with the various approximations that are used. The inelastic scattering of strongly absorbed particles is emphasized in the discussion of direct reactions. 168 references. (D.C.W.)

9936 PHENOMENOLOGICAL COLLECTIVE MODELS. Rowe, D. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 93-161 of STI/PUB-145.

A review of the phenomenological models is presented with consideration of the microscopic formalisms. Spherical nuclei are discussed in terms of the collective vibrational model, the unified model, the adiabatic model, and the vibrating potential model. The corresponding discussion of deformed nuclei deals with the collective rotational model, the unified model for rotations, the Nilsson model, the irrotational flow model, the cranking model, and the pushing model. (D.C.W.)

9937 ISOSPIN AND ITS CONSEQUENCES IN NUCLEAR PHYSICS. Temmer, G. M. (Rutgers-The State Univ., New Brunswick, N. J.). pp 163-242 of STI/PUB-145.

A survey of the isospin formalism and of its implications for nuclear forces, reactions, and structure is presented. 84 references. (D.C.W.)

9938 CALCULATIONS OF NEUTRON-CAPTURE CROSS-SECTIONS WITH THE STATISTICAL MODEL. Benzi, V. (CNEN, Bologna). pp 243-55 of STI/PUB-145.

The numerical evaluation of radiative capture cross sections using statistical models is briefly discussed including formulas for nuclear level densities and spacings, for penetrabilities, and for radiative widths. The results of some calculations are compared with experimental data. (D.C.W.)

9939 ISOBARIC ANALOGUE RESONANCES IN THE $f_{7/2}$ REGION BY (p,nγ) REACTIONS. Ricci, R. A. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). pp 257-65 of STI/PUB-145.

The investigation of isobaric analog resonances in the $f_{7/2}$ region by spectroscopy of the gamma rays from residual nuclei in (p,n) reactions is discussed. The reaction ^{48}Ca(p,nγ)^{48}Sc is treated as an example. (D.C.W.)

9940 COLLISION THEORY. Villars, F. (Massachusetts Inst. of Tech., Cambridge). pp 269-332 of STI/PUB-145.

The collision of a nonrelativistic elementary particle with a fixed potential is discussed in the context of a review of scattering states, the S-matrix, the T-matrix, and the unitarity condition. An attempt is also made to clarify the relation between the time-independent description in terms of wave packets. Composite targets are then introduced, and the case of identical particles is treated in detail. The method of second quantization is introduced, and the formulation of collision problems for identical particles in this framework is outlined. Nuclear reactions are then discussed in the framework of the Hartree-Fock theory. (D.C.W.)

9941 MULTICHANNEL SCATTERING FORMALISM AND THRESHOLD EFFECTS. Fonda, L. (Univ., Trieste, Italy). pp 333-67 of STI/PUB-145.

The general multichannel scattering formalism is considered in detail. Scattering systems are covered for which a Hamiltonian can be defined and can be split into two parts, one of which describes the free and internal motion of the fragments of a given configuration. A brief account is then given of the anomalies that appear in the reaction and scattering cross sections as functions of energy at the opening of an inelastic process. (D.C.W.)

9942 S-MATRIX THEORY OF NUCLEAR RESONANCE REACTIONS. Humblet, J. (Univ., Liege). pp 369-417 of STI/PUB-145.

The S-matrix theory of nuclear reactions, which involves the direct parametrization of the S-matrix and the introduction of a set of complex eigenvalues with real and imaginary parts corresponding to the position and total width of the resonances, is discussed in detail. 52 references. (D.C.W.)

9943 NUCLEAR RESONANCE REACTIONS AND S-MATRIX ANALYTICITY. McVoy, K. W. (Univ. of Wisconsin, Madison). pp 419-98 of STI/PUB-145.

A review is presented in which the relations of the complex poles and residues of the S-matrix to a variety of physical scattering properties such as barrier penetrability, branching ratios, resonance circles, Levinson's Theorem, and bound states are examined. Elastic resonances are considered first, including overlapping resonances and the difference between their R-matrix and S-matrix widths. Many-channel resonances are then discussed; in this case the one-pole approximation to S, when made unitary, is found to include the Breit-Wigner approximation and to provide its generalization to the case of a nonelastic background. (D.C.W.)

9944 APPLICATIONS OF RESONANCE SCATTERING THEORY IN NUCLEAR PHYSICS. Lemmer, R. H. (Massachusetts Inst. of Tech., Cambridge). pp 499-530 of STI/PUB-145.

Scattering theory is discussed with emphasis on possible applications of the theory to problems of nuclear structure. The Feshbach formalism is outlined, and the requirement of antisymmetry between the incident nucleon and the nucleons in the target is examined. The characterization of the complex optical potential by the application of scattering formalism to the problem of average cross sections is considered, and the conditions under which doorway states could produce intermediate structure in cross sections are investigated. Analog resonances are also discussed. (D.C.W.)

9945 MICROSCOPIC COLLECTIVE THEORIES. Rowe, D. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 531-621 of STI/PUB-145.

Several methods of treating the many-body problem are discussed with emphasis on the treatment of residual interactions. Several approximations, most of which can be regarded as extensions of the Hartree-Fock method, are considered. (D.C.W.)

9946 EQUILIBRIUM SHAPES OF LIGHT NUCLEI. Ripka, G. (CEN, Saclay, France). pp 623-81 of STI/PUB-145.

Kinetic and potential energy are calculated using the independent-particle model, as are separation energies and single-particle energies. The Hartree-Fock theory is then applied, and Hartree-Fock calculations are performed considering only the mixing of the degenerate states that belong to a major shell of the oscillator well. Rotational bands in 2s1d-shell nuclei are then considered, and Hartree-Fock calculations are performed taking account the mixing of major shells. (D.C.W.)

9947 GROUP THEORY AND NUCLEAR STRUCTURE. Moshinsky, M. (Univ. de Mexico, Mexico City). pp 683-772 of STI/PUB-145.

The application of group-theoretical methods to the analysis of many-body problems associated with the understanding of nuclear structure is outlined. These methods can be implemented both in the second-quantized formalism and in the ordinary configuration and spin-isospin space of the particles involved. In the first case, the Hamiltonian is expressed in terms of the generators of a certain fundamental group, and the states are characterized by the irreducible representations of subgroups of this group. Explicit procedures are given for the determination both of these states and of the matrix elements of physical interactions with respect to them, leading finally to the determination of energy levels and eigenstates. In the second case, the configuration part of the state is described in terms of harmonic-oscillator states to make full use of the symmetry group associated with them. It is shown that this permits a detailed discussion of few-nucleon problems, shell-model states, and clustering effects. (D.C.W.)

9948 SHELL-MODEL DESCRIPTION OF NUCLEAR REACTIONS. Dietrich, K. (Univ., Heidelberg). pp 773-91 of STI/PUB-145.

A formulation of the dynamical theory in which the shell model is used explicitly from the outset as a lowest-order approximation to the scattering is outlined. The case of one doorway state embedded in one continuum is treated following the introduction of the basic formalism. The simultaneous occurrence of shell-model resonances and compound-nucleus resonances is also considered. The formalism is then generalized to include direct reactions and the scattering of light projectiles, and diagonalization of the Hamiltonian in the subspace of continuous shell-model states is discussed. (D.C.W.)

9949 COMPARATIVE DISCUSSION OF TWO FORMAL THEORIES OF RESONANCE REACTIONS. Fonda, L. (Univ., Trieste, Italy). pp 793-805 of STI/PUB-145.

A comparison of the Feshbach and Fonda-Newton formalisms for resonance reactions is made. It is shown that the essential difference between the two formalisms consists in the identification of the compound-nucleus states. (D.C.W.)

9950 TREATMENT OF PAIRING CORRELATIONS WITHOUT VIOLATION OF CONSERVATION LAWS. Jean, M.; Campi, X.; Vucetich, H. (Institut de Physique Nucleaire, Orsay, France). pp 807-27 of STI/PUB-145.

An approximation scheme that formally is quite close to the Hartree-Bogolubov theory but in principle avoids the difficulties associated with the violation of conservation laws is presented.

9951 FUNDAMENTAL METHODS IN NEUTRON SPECTROSCOPY. Rae, E. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 831-906 of STI/PUB-145.

Methods of neutron spectroscopy that can be applied to the study of nuclear structure are discussed. Neutron sources, detectors, and spectrometers are discussed as are low-energy neutron spectroscopy and intermediate-energy neutron spectroscopy. 115 references. (D.C.W.)

9952 A METHOD OF APPROXIMATION FOR THE FORM FACTOR OF THE NUCLEAR STRIPPING AND PICK-UP REACTIONS. Kawai, Mitsuji (Tokyo Inst. of Tech.); Yazaki, Koichi Progr. Theor. Phys. (Kyoto), 38: 850-62(Oct. 1967).

A method of approximately calculating form factors of stripping and pickup reactions in the DWBA is presented. The method is useful if the nuclear wave functions are known accurately in the internal region. Then the form factor which is accurate also in the surface region can be obtained, its correct asymptotic form being automatically guaranteed by the formalism. Quantitative features of the approximation are studied in detail for the case of the one-body problem in which exact wave functions in the Woods–Saxon potential are compared with the ones calculated by the method using appropriately chosen harmonic oscillator wave functions. Application of the method to various cases of practical interest, including the two-particle transfer reaction, is discussed. (auth)

9953 ROLE OF COULOMB POTENTIAL IN $\Delta T = \pm 1$ FERMI TRANSITIONS. Ikeda, Akitsu (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 38: 832-9(Oct. 1967).

Nuclear matrix elements of $\Delta T = \pm 1$ Fermi transitions are calculated by treating the Coulomb potential accurately. The method proposed by K. Ikeda and J. I. Fujita for calculation of the matrix elements of hindered transitions is adopted. The shell model and the pairing model wave functions are used for the model wave functions; as the single-particle wave functions, the Woods–Saxon and the harmonic-oscillator wave functions are employed. It seems that the experimentally obtained matrix elements can be reproduced by taking into account only the Coulomb potential without introducing any other charge-dependent force. (auth)

9954 EFFECTS OF CORRELATION IN THE CORE ON THE MOTION OF OUTER TWO NUCLEONS. Kuriyama, Atsushi; Nagata, Sinobu; Bando, Hiroharu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 38: 840-9(Oct. 1967).

The effects of the two-particle-two-hole correlation in the core on the motion of the outer two particles and two holes are studied. Using a method of scattering eigenmode diagonalization, one can derive the renormalization effect on the one-particle energy and the backward configuration mixing to the state of the outer nucleons. It is found that the effects are considerable, and the level schemes of ^{18}O, ^{18}F, and ^{14}N are reproduced by using the reaction matrix as the residual interaction. (auth)

9955 MODELS FOR NUCLEAR STRUCTURE OF SPHERICAL NUCLEI. Gordon, Glen E.; Coryell, Charles D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-905. J. Chem. Educ., 44: 636-46(Nov. 1967). (MIT-905-89).

A review is presented of the basic nuclear shell model which assumes no configuration mixing; then the effective-interaction method which includes some mixing; and finally the extreme model of configuration mixing, the superconductor model. The nuclear shell (or independent-particle) model was the first important step towards quantitative understanding of nuclear levels. The interactions of a specific nucleon with the other nucleons present are approximated as the interaction of the nucleon with a static potential well. Shell-model calculations since 1949 essentially involve different methods of dealing with the residual forces. The effective-interaction and superconductor methods which are described represent 2 extreme starting points for the treatment of these forces. It is emphasized that the residual forces differ appreciably from the free-nucleon interactions. How the δ-range residual interaction may be used to treat strong pairing effects and, in combination with a spin–spin dependent part, the neutron-proton interactions in odd-odd nuclei is discussed. The so-called effective-interaction method can be used to make shell-model predictions over large regions of nuclei and does not require any assumptions about the shapes of potentials and strengths for various types of interactions. Advantages of the shell model in terms of systematizing existing knowledge of nuclear levels and predicting as yet unmeasured quantities are discussed. The orbitals provided by it may be used as the starting point for other models. Thus the superconductor model uses the shell-model orbitals as a starting point and considers as residual interactions a strong pairing force, similar to the δ force treated above, and a long-range P_2 force. The usefulness and weakness of this model are examined. 41 references. (BBB)

9956 THREE-BODY EFFECTIVE INTERACTION IN DEUTERIUM. **Dodd, L. R.; Strobel, G. L. (Univ. of California, Davis). Contract AT(11-1)-gen-10. Phys. Rev., 165: 1-6 (Jan. 5, 1968). (UCD-CNL-79).**

The reduction of a simple, nonrelativistic three-body problem to an equivalent two-body problem is discussed. The theory is applied to deuterium, which is treated as a spinless three-body system with only two pair interactions present. The neutron-electron interaction is ignored and the neutron-proton interaction is assumed to be a separable s-state Yamaguchi potential. The electron-proton interaction is taken as a static Coulomb interaction. With these assumptions, an exact expression for an effective electron-deuteron potential, which depends only on the electron-deuteron relative coordinates and the total three-body energy, is derived. It is shown how this effective interaction may be compared using first-order perturbation theory with the corresponding effective potential of a model problem in which the structure of the deuteron is ignored. The three-body theory is used to estimate the contribution to the Lamb shift in deuterium arising from the finite size and polarizability of the deuteron. The effects of polarizability are found to be insignificant, and hence the usual two-body description of deuterium is justified. (auth)

9957 ANALYSIS OF NUCLEAR EVAPORATION SPECTRA: CHARGED PARTICLE EMISSION. **Williams, David C. (Los Alamos Scientific Lab., N. Mex. Sandia Lab., Albuquerque, N. Mex.).; Thomas, T. Darrah. Nucl. Phys., A107: 552-68 (1968).**

It is shown that erroneous values of the nuclear level density parameter a may be obtained when nuclear evaporation spectra are analyzed by the usual formalism that does not explicitly take into account the spin dependence of the level density of the residual nucleus. The value obtained from nucleon spectra will usually be too large, and the apparent value will depend upon both the mode of formation of the compound nucleus and the type of particle emitted. The emission ratios for competing particles can depend significantly upon the compound nucleus angular momentum and therefore, upon how the compound nucleus is formed. The effect of spin fractionation is important in many cases. None of the factors taken into account can explain the decrease in a with increasing bombarding energy that has been reported for some neutron evaporation spectra, although it is predicted that alpha-particle spectra will show this effect in some cases if the nuclear moment of inertia is small enough. In general, the calculated spectra depend upon the magnitude of the spin-cut-off parameter as well as upon the level-density parameter, and the behavior of the spin-cut-off parameter as a function of excitation energy is also shown to be important. It will therefore be difficult to extract meaningful values of the level density parameter from the analysis of a single evaporation spectrum. On the other hand, it may prove possible to obtain information on both the energy dependence and the spin dependence of the nuclear level density through the study of several suitably chosen evaporation spectra that all involve the same residual nucleus. (auth)

9958 CORRECTION EFFECTS IN THE THEORY OF INTERNAL BREMSSTRAHLUNG. **Gebhardt, Dieter (Univ., Erlangen, Ger.). Nucl. Phys., A107: 593-600(1968). (In German).**

A critical review of papers concerning the Coulomb effect in the theory of internal bremsstrahlung is given. Further correction effects are examined. The results are discussed in comparing them with experimental values for ^{35}S, ^{32}P and ^{90}Y. The well-known discrepancies between theoretical and experimental results for the IB spectrum remain, but differential angular-correlation measurements are in good agreement with theory. (auth)

9959 THE AMPLITUDE OF NUCLEAR PHOTON SCATTERING AND ITS THOMSON LIMIT. **Silbar, R.; Werntz, Carl; Uberall, H. (Catholic Univ. of America, Washington, D. C.). Nucl. Phys., A107: 655-8(1968).**

It is explicitly shown how, in the long wavelength limit of photon scattering by a nucleus, the scattering amplitude separates into a nuclear Thomson term, which remains finite and represents scattering from the nuclear charge distribution as a whole, and a nuclear Rayleigh term ("nuclear resonance"), which vanishes as ω^2 for $\omega \to 0$ and represents excitation of the internal coordinates. (auth)

9960 GROUP THEORY OF HARMONIC OSCILLATORS. IV. DYNAMICS OF THE TWO-, THREE-, AND FOUR-PARTICLE SYSTEMS. **Kramer, P.; Moshinsky, M. (Univ., Mexico, Mexico City). Nucl. Phys., A107: 481-522(1968).**

The matrix elements of a general Hamiltonian are calculated with respect to states of two, three, and four particles derived previously using techniques of group theory applied to harmonic oscillator states. Explicit tables are given for the four-particle system up to two quanta, including the kinetic energy, central interactions with all types of exchange, two-particle spin-orbit, tensor, and Coulomb interactions. The generalizations to an arbitrary number of particles and quanta are also discussed. (auth)

9961 TRAPPING STATES IN STRIPPING REACTIONS. **Edwards, Steve (Florida State Univ., Tallahassee). Nucl. Phys., A107: 523-8(1968).**

Gross effects of intermediate state structure in angular distributions from stripping reactions are investigated using the simple "trapping-state" model of Davis in a plane-wave Born approximation stripped theory. The resulting angular distribution is compared with the Butler angular distribution and the data for the reaction $^{12}C(d,p)^{13}C_{3.85}$ for a deuteron bombarding energy of 2.80 MeV (lab). It is concluded that this simple model can be expected to be useful in the inclusion of these effects in more sophisticated analyses of such reactions. (auth)

9962 ANALYSIS OF QUASI-ELASTIC (^3He,t) REACTIONS. **Frahn, W. E.; Wiechers, G. (Univ. of Cape Town). Phys. Lett., 26B: 5-7(Dec. 11, 1967).**

Differential cross sections of quasielastic (^3He,t) reactions are analyzed by means of a simple closed formula. Simultaneous fits of the angular distributions for elastic and quasielastic scattering prove the validity of the phase rule for transition to the ground isobaric analog state. (auth)

9963 SINGLE-PARTICLE STRENGTH IN NUCLEI. **Clement, C. F. (Univ. of Washington, Seattle). Contract AT(45-1)-1388B. Phys. Rev. Lett., 20: 22-4(Jan. 1, 1968).**

Sum rules are derived which give the distribution of states consisting of an A-particle nucleus times a single-particle form factor among all physical states of the (A + 1)-particle system. A similar derivation of Butler's new stripping theory clarifies some of its physical content. (auth)

9964 NUCLEON EMISSION IN ELECTRON SCATTERING. **de Forest, Taber Jr. (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 45: 365-403(1967).**

Coincidence electron scattering experiments at large energy transfer in which an emitted nucleon is detected in addition to the electron are potentially very useful since they probe the detailed structure of the nucleus. The most important process which contributes in such an experiment is quasi-elastic scattering, and a review of how the cross section for this process may be used to obtain single particle momentum distributions and binding energies is made. It is also shown that for certain regions the cross section comes only from processes involving nucleon–nucleon interactions and, thus, can be used to investigate such interactions in the nucleus and possibly the ground-state correlations they produce. As an order of magnitude estimate, the Coulomb cross section in such a region for a hard-sphere Fermi gas is calculated to lowest order of the gas parameter. The results indicate that such experiments should be feasible. The general form of the double coincidence cross section is also discussed in Born approximation, and it is shown that it is a linear combination of four generalized form factors which can be separated experimentally. As is the case for non-coincidence experiments, this provides a method for extracting the Coulomb cross section. (auth)

9965 FEYNMAN-DIAGRAM APPROACH IN HEAVY-ION INTERACTIONS. **Taffara, L. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Nuovo Cim. (10), 52B: 570-3(Dec. 11, 1967).**

An extension of Feynman diagram techniques to transfer reactions between two complex nuclei is outlined. (D.C.W.)

9966 NUCLEAR VIBRATIONS AS A CONSTRAINED HARTREE-FOCK PROBLEM. **Bar-Touv, Jacob (Univ. of California, Los Angeles). Phys. Rev., 164: 1241-6(Dec. 20, 1967).**

The constrained Hartree–Fock equations and the adiabatic approximation are combined in a model for describing collective vibrations of deformed nuclei. The β vibrations of the Hartree–Fock ground-state determinant are affected by imposing the constraint on the quadrupole single-particle operator Q_{20}. The geometrical parameter q of the vibrations is thus identified with the expectation value of Q_{20} in a state $\phi(q)$ given by the self-consistency determinant. The energy surface, force constant, and mass parameter are directly related to the intrinsic structure of the nucleus. A Hill–Wheeler representation for the vibrational states is used to extract the one-phonon intrinsic wave function out of the ground-state determinant. The model is tested numerically by applying it to ^{20}Ne and identifying the first excited 0^+ with the one-phonon vibrational state. The results of the present adiabatic model are compared explicitly with those of the alternative particle-hole model. The comparison between the two models shows that when adiabaticity conditions exist in the self-consistent field, both models are equally capable of giving a fair description of the vibration of deformed nuclei. (auth)

9967 NUCLEON–NUCLEON SCATTERING FROM ONE-BOSON-EXCHANGE POTENTIALS. II. INCLUSION OF ALL MOMENTUM-DEPENDENT TERMS THROUGH ORDER p^2. Bryan, R. A. (Univ. of California, Livermore); Scott, Bruce I. Phys. Rev., 164: 1215-22(Dec. 20, 1967).

The nucleon–nucleon interaction in relative angular momentum states $l \geq 1$ is described over the energy range 25 to 350 MeV by a potential used in conjunction with the Schrödinger equation. The potential is a superposition of pole terms obtained from single exchanges of ω, ρ, π, η, σ_0, and σ_1 mesons and, rather than taking the usual static limit, all terms of order k^2/M^2 are retained. Because of these momentum-dependent terms, no cutoff is necessary in $l \geq 1$ states. The meson coupling constants and the masses of the scalar mesons (σ_0 and σ_1) are the parameters which are adjusted to fit the experimentally determined phase parameters. A comparison with the data is given, showing a quantitative fit (X^2/datum = 1.6) when the model is augmented with reasonable values of the s-wave parameters. (auth)

9968 ELECTRON SCATTERING, ft VALUES, AND SINGLE-PARTICLE REDUCED WIDTHS AS CALCULATED FROM PROJECTED HARTREE–FOCK WAVE FUNCTIONS. Gunye, M. R. (Bhabha Atomic Research Centre, Bombay); Warke, Chindhu S. Phys. Rev., 164: 1264-7(Dec. 20, 1967).

Using the projected Hartree–Fock wave functions, the nuclear form factors in electron scattering, ft values in β decay, and reduced widths of nuclear levels in direct reactions are calculated in the 2s1d-shell nuclei. The agreement between the calculated and the experimental ft values is good; the form factors and the reduced widths are also predicted satisfactorily. (auth)

9969 STATISTICAL PROPERTIES OF THE SCATTERING AMPLITUDE AND CROSS SECTIONS USING THE STATISTICAL COLLISION MATRIX. Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 164: 1316-19(Dec. 20, 1967).

The statistical collision matrix is used to study the statistical distribution of the random part of the partial scattering amplitude and the partial fluctuation cross section. Using simplifying assumptions, explicit expressions are obtained for the lower moments of the partial scattering amplitude for the inelastic processes. It is shown that the real and imaginary parts of the fluctuating scattering amplitude have a Gaussian distribution with the same variance. Using ensemble averages of the resonance parameters of the statistical collision matrix, an expression is obtained for the partial reaction fluctuation cross section in the region of overlapping resonances. A remark is made about the partial elastic fluctuation cross section. (auth)

9970 MOMENT OF INERTIA IN THE 2s-1d SHELL. Das Gupta, S.; Van Ginneken, A. (McGill Univ., Montreal). Phys. Rev., 164: 1320-4(Dec. 20, 1967).

For the purpose of evaluating the moment of inertia, a method is proposed which can be used for any nucleus (with rotational spectrum) in the s-d shell—even-even, odd mass, or odd-odd. Examples are shown. (auth)

9971 MORSE FUNCTION AND VELOCITY-DEPENDENT NUCLEON–NUCLEON POTENTIALS. Darewych, G.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., 164: 1324-31(Dec. 20, 1967).

A static soft-core potential (the Morse potential) and three representative velocity-dependent N-N potentials are investigated. First, the problem of adjusting potentials to maintain the 1s state bound near zero energy is studied, and two integral criteria are tested. For the Morse potential a convenient analytical expression for the s-wave phase shifts is derived. By fitting experimental phase shifts in the energy range $E_{lab} \leq 400$ MeV for elastic nucleon–nucleon scattering, the potential parameters for the $^1s_0$ and $^3s_1$ states are evaluated. A phenomenological and two-meson-theoretic one-boson-exchange potentials in s states which are representative of a number of N-N potentials in current use are then examined and compared. Ways of characterizing these potentials which are helpful in assessing their scattering consequences are pointed out. It is shown that different mechanisms embodied in such potentials can account equally well for the negative s-wave phase shifts observed at higher energies. (auth)

9972 THREE-BODY CORRELATIONS IN REACTION-MATRIX CALCULATIONS. Bhakar, B. S.; McCarthy, R. J. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Phys. Rev., 164: 1343-53(Dec. 20, 1967). (ORO-1316-42).

An improved method of treating three-body cluster correlations in reaction-matrix calculations is presented and applied to nuclear matter. A three-particle reaction matrix is defined which allows three particles to interact with each other in all possible ways after specifying the particles involved in the initial and terminal interactions. The method is similar to that proposed by Bethe but, since all off-energy-shell terms can be treated separately, full advantage can be taken of the Faddeev formalism as applied to the three-nucleon system. The Pauli exclusion operator is included in calculating on-energy-shell reaction-matrix elements but is neglected in the off-energy-shell terms. Numerical calculations are presented for two spin-independent, s-state, separable potentials, one of which contains a hard-shell repulsive term. Higher-order terms are found to be important for the hard-shell potential but not for the simple attractive potential. In both cases the total three-body correlation energy is found to be small. (auth)

9973 INTERNAL IONIZATION DURING BETA DECAY. Stephas, Paul (Univ. of British Columbia, Vancouver); Crasemann, Bernd. Contract AT(45-1)-1925. Phys. Rev., 164: 1509-20(Dec. 20, 1967). (TID-23877).

In nuclear β decay, atomic excitation, including ionization, can occur because of (i) imperfect overlap of parent and daughter orbital electron wave functions, and (ii) scattering of atomic electrons by the β particle ("direct collisions"). In order to evaluate the relative importance of these two processes and test the possible role of nuclear matrix elements in orbital-electron ejection, published work on the subject has been reviewed. New measurements, were performed determining the total probability of K ionization in the β decay of ^{99}Tc ($4.8 \pm 0.3 \times 10^{-4}$ per β) and ^{147}Pm ($9.3 \pm 1.4 \times 10^{-5}$ per β). The K ionization probability as a function of β energy was also measured; a strong energy dependence is found, in disagreement with the traditional wave-function overlap theory. This theory is improved by including phase-space considerations, using relativistic electron wave functions in the calculation of the pertinent matrix elements, and paying careful attention to the antisymmetrization of the final-state wave function. The predictions of the modified wave-overlap theory agree very well with experiment. Direct collisions appear to play only a minor role. The calculations indicate that the ionization probability is inhibited in forbidden decay. A possible change in the shape factor for transitions accompanied by internal ionization is predicted. (auth)

9974 THEORY OF NUCLEAR REACTIONS BASED ON A SECOND-QUANTIZATION FORMALISM. Ballot, J. L.; Becker, F. (Institut de Physique Nucleaire, Orsay, France). Phys. Rev., 164: 1285-94(Dec. 20, 1967).

A formalism for determining nuclear reaction amplitudes is given in the framework of a second-quantized theory. It allows a unified description of all possible reactions between nucleons, nuclei, and elementary particles; it yields, without any approximation, integral equations for the n-body amplitudes in terms of the solution of 2 .... (N-1) body problem; these integral equations can be given a graphical representation. As an example, this formalism is applied to elastic and inelastic nucleon-deuteron scattering. (auth)

9975 MODIFIED DISTORTED-WAVE BORN SERIES. Rihan, T. H. (Atomic Energy Establishment, Cairo). Phys. Rev., 164: 1247-52(Dec. 20, 1967).

A method is developed for obtaining a convergent solution for the three-body scattering amplitude in a modified distorted-wave representation. An integral equation for the three-body scattering operator is derived in a similar manner to that of Greider and Dodd. A new analytical form for the transition amplitude of the stripping processes is obtained after some reasonable approximations. This form contains the Butler cutoff and distorted-wave treatments as limiting cases. A curve is drawn to show the significance of this new Born term together with the usual Butler cutoff model for the ^{28}Si(d,p)^{29}Si reaction. (auth)

9976 FIRST-FORBIDDEN BETA-TRANSITIONS BETWEEN K-MIXED STATES. Bogdan, D.; Lipnik, P. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim. (10), 52B: 273-87(Dec. 11, 1967).

Assuming a K-mixture in the ground state of the ^{152}Eu nucleus, one can determine the relative intensity of the different K-components by comparison with the experimental data. The results are also valid for the ^{154}Eu and ^{160}Tb cases assuming the same Nilsson-model configurations for these nuclei. In the case of the ^{170}Tm $(1-1) \rightarrow {}^{170}Yb(0+0;\ 2+0)$ beta transitions, the nuclear matrix elements were calculated assuming a $K = 0$ mixture in the ^{170}Tm ground state. The results showed that, assuming reasonable $K = 0$ mixtures, it is not possible to obtain satisfactorily calculated ft values. (auth)

9977 SPIN-ORBIT INTERACTION IN THE COLLECTIVE AND DIRECT NUCLEON RADIATIVE CAPTURE. Longo, G.; Saporetti, F. (Comitato Nazionale Energia Nucleare, Bologna). Nuovo Cim. (10), 52B: 539-51(Dec. 11, 1967).

The expression for the nucleon radiative capture cross section by nuclei via a collective mechanism is completed in order to take into account the spin-orbit interaction. The direct and collective cross sections for ^{208}Pb(n,γ) and ^{208}Pb(p,γ) reactions are calculated. A good agreement between calculated and measured cross sections is obtained using optical parameters which describe quite accurately experimental differential elastic scattering, reaction cross sections, and polarization data. (auth)

9978 ENERGY DEPENDENCE OF THE DEUTERON DIFFUSENESS PARAMETER. Huq, A.; Islam, M. M. (Atomic Energy Centre, Dacca, Paskistan). Nuovo Cim. (10), 52B: 565-6 (Dec. 11, 1967).

An optical model analysis of some experimental data for deuteron elastic scattering by ^{114}Cd was performed. It was found that the inclusion of energy dependence in the deuteron diffuseness parameter gave an adequate account of the depth of the imaginary part of the optical potential. (D.C.W.)

9979 APPROXIMATE SCATTERING SOLUTIONS OF THE DIRAC EQUATION FOR ELECTRON-NUCLEUS PROCESSES IN LIGHT NUCLEI. Scheck, F.; Stingl, M. (Univ., Freiburg i. B.). Z. Phys., 209: 93-110(1968).

Scattering solutions of the second-order Dirac equation for the case of the Coulomb potential, which are correct to first order in the coupling constant $Ze^2/\hbar c$, are investigated and are found to describe pure Coulomb scattering equally well as the Sommerfeld-Maue wave functions. Errors introduced by the use of these solutions are studied in a numerical calculation of cross sections for nuclear electric-quadrupole excitation by high-energy electrons. The use of these wave functions is suggested for simplified calculations of lowest-order Coulomb corrections to Born approximation results for various electron-nucleus processes. (auth)

9980 CALUCLATIONS WITH PHENOMENOLOGICAL FORCES. Brink, David M.; Peierls, Rudolf E. (Oxford Univ.). Comments Nucl. Particle Phys., 1: 206-10(Nov.-Dec. 1967).

The purposes for which the phenomenological approach is still very important, in spite of the increased interest in realistic forces, are discussed. Some calculations dealing with nuclei near closed shells and using phenomenological forces are reviewed. (D.C.W.)

9981 APPLICATIONS OF GENERALIZED B-MATRIX THEORY TO SIMPLE SCATTERING MODELS. Purcell, James Eugene. Cleveland, Ohio, Case Inst. of Tech., 1966. 116p.
Thesis.

The generalized R-matrix formalism for nuclear reactions of Tobocman and Nagarajan is studied by applying it to simple potential scattering problems. Particular attention is devoted to zero potential, square-well potential, and to a pair of coupled square wells. In each case, approximate basis states are found by matrix diagonalization, and the scattering wave functions are expressed in terms of this basis in accordance with the theory. Numerical comparisons between the exact and approximate results indicate that generally the approximation converges fairly rapidly and gives a good representation of the exact cross section. However, the approximate results deviate seriously from the exact cross section near certain energy values causing nonphysical resonances to appear. Such false resonances can be easily identified and, in fact, will not appear in most practical applications. (Diss. Abstr.)

9982 RECENT APPLICATIONS OF PERTURBED ANGULAR CORRELATIONS. Matthias, E. (Univ. of California, Berkeley). pp 595-625 of Hyperfine Interactions. Freeman, Arthur J.; Frankel, Richard B. (eds.). New York and London, Academic Press, 1967.

The recent experimental development in the field of perturbed angular correlations is sketched. Some conventional angular correlation methods are discussed. Nuclear magnetic resonance in radioactive states with half lives down to 10^{-8} sec using angular correlations or distributions to detect the resonance is covered. (M.H.R.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 8266, 8269, 8273, 8289, 8313, 8317, 8536, 8623, 8694, 8696, 8739, 8742, 8806, 8822, 8846, and 8847.

9983 (ACNP-67515) PATHFINDER ATOMIC POWER PLANT. DYNAMICS REACTIVITY TESTS (433). Stone, J. T. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Dec. 1967. Contract AT(11-1)-589. 118p. Dep. CFSTI.

For Northern States Power Co., Minneapolis, Minn. and Central Utilities Atomic Power Associates.

Dynamics reactivity tests for the Pathfinder Atomic Power Plant are described. The effects of pressure disturbances, recirculation flow changes, recirculation pump trip tests, control rod movements, and feed-water flow changes and temperature changes are presented. (D.C.C.)

9984 (AECL-2786) LOCATING FUEL FAILURES BY FISSION PRODUCT DEPOSITION IN CANDU-PHW REACTORS. Lipsett, J. J.; Palmer, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov. 1967. 27p. (CONF-671119-1). Dep. CFSTI. CAN $1.00.

From Conference on Failed Fuel Element Detection, Vienna, Austria.

Many systems for locating fuel cladding failures are costly and difficult to maintain because they usually employ a complex arrangement of sample flows controlled in long lengths of small-diameter tubing. In power reactors of the pressure-tube type, the problem may be simplified with a Ge(Li) γ-ray spectrometer mounted near the end face of the reactor and set to scan the outlet coolant pipes for deposited fission products. Experiments in the NRX reactor loops and in the NPD power reactor tested this concept and the results are encouraging. The major depositing fission products observed are 67-hr ^{99}Mo and 78-hr ^{132}Te, and they show a strong affinity for certain metallic surfaces, e.g., Monel and nickel. Interference from coolant activation products (e.g. ^{16}N, ^{17}F, ^{19}O) and corrosion products (e.g. ^{51}Cr, ^{56}Mn, ^{60}Co, ^{64}Cu, ^{187}W) has been tolerable. The experimental results have been extrapolated to the case of CANDU-PHW reactors. It appears that the technique would be satisfactory if a Monel surface was installed in the outlet coolant pipe from each channel. (auth)

9985 (AECL-2948) COMPUTER CONTROL IN THE DOUGLAS POINT NUCLEAR POWER STATION. Siddall, E.; Smith, J. E. (Atomic Energy of Canada Ltd., Sheridan Park (Ontario)). Sept. 1967. 19p. (CONF-670917-10). Dep. CFSTI. CAN $0.50.

From Symposium on Heavy Water Power Reactors, Vienna, Austria.

By using time multiplexing techniques, the high data processing capabilities of a single digital computer can be used to replace a multiple analogue control system with a saving in costs and better operation. A digital computer controller was incorporated in the control system for the Douglas Point Nuclear Power Plant. Experience in the design phase has been gained and operating experience has been encouraging. (auth)

9986 (AI-CE-TDR-1089) HWOCR MULTICHANNEL CROSS FLOW STUDIES. Felten, L. D.; Cassidy, R. B.; Dodd, J. W. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., [Windsor, Conn.]). Nov. 15, 1966. 54p. Dep. CFSTI.

Velocity measurements have confirmed that the velocity profile is essentially flat over the tricusp and side flow channels of the multichannel test section used for the present experiment. The ratio of cross flow to axial flow for the tricusp channel was 0.65×0.16 ft^{-1} which is equivalent to 0.44 ± 0.11 lb/sec ft for 120°F water at a velocity of 26 ft/sec. (auth)

9987 (ANL-7368) ANALYSIS OF THE INITIAL CRITICAL EXPERIMENTS OF THE EBWR PLUTONIUM RECYCLE PROGRAM. Kier, P. H. (Argonne National Lab., Ill.). Aug. 1967. Contract W-31-109-eng-38. 41p. Dep. CFSTI.

The experimental results and the analysis for measurements of two Pu-fuel critical configurations, temperature coefficients of reactivity, H_3BO_3 worths and control-rod bank worths are presented. The temperature coefficients and H_3BO_3 worths were measured for the 36-Pu assembly loading and for the full fuel loadings. These critical experiments led to a revised computational model, which is also described. (auth)

9988 (ANL-7391) REACTOR DEVELOPMENT PROGRAM. Progress Report, October 1967. (Argonne National Lab., Ill.). Nov. 30. 1967. Contract W-31-109-eng-38. 185p. Dep. CFSTI.

REACTOR FUEL ELEMENTS—fission gas release from, comparison of calculated and measured; burnup of uranium-plutonium; cladding alloys for, mechanical properties of; bowing of EBR-2, postirradiation measurements of; fission product-PuO_2-UO_2, fluorination of pellets of
CRUCIBLES—materials for containing reactive alloys of uranium-zirconium, development of
URANIUM CARBIDES, PLUTONIUM CARBIDES—PuC-UC, compatibility with jacketing materials
COATINGS—mechanical properties of fuel element; corrosion of fuel element, effects of sodium on
REACTORS, LIQUID METAL-COOLED—neutron fluxes in, detailed calculation of effects of interfaces between resonance-scattering media on; sodium coolants for, analytical and in-line techniques for detection of impurities in
REACTORS, BREEDER—neutron flux calculations for, effects of interfaces between resonance-scattering media on
CRITICAL ASSEMBLIES—Doppler coefficient and plutonium systems studies in ZPR-3, summary of; use of ZPR-3 for FFTF mockup studies; reactivity worth measurements in ZPR-3, FTR
FAST TEST REACTOR—neutron cross sections for, generation of core-averaged
SODIUM—impurity detection in, analytical and in-line techniques for; analyses for carbon in; separation of cesium from liquid, temperature and mixing effects on
FLOWMETERS—testing of prototype magnetic
EXPERIMENTAL BREEDER REACTOR-II—control rod and and driver assemblies for, reactivity worth of; power coefficient for, effects of core size on; transfer function measurements in, results in terms of feedback of; reactivity measurements using rod-drop technique in; sodium coolant for, deposition of cesium from flowing primary; sodium coolant for, chemical analyses for tin and bismuith in flowing primary; experimental irradiations in, October 1967 status of; operations problems with; Fuel Cycle Facility for, production summary for
CARBON—content in sodium, determination of
URANIUM ALLOYS—fissium-U, fissium constituents in, analytical methods for determining
FISSIUM—fissium-U, constituents of, analyses of
SUPERHEATERS—vibration studies on
NEUTRONS, FAST—fission rate measurements in EBR-2, statistical error due to angular correlation in
URANIUM ISOTOPES U-235—fission fragment values for, mass-angle dependence of
REACTOR FUELS—swelling of, effects of trace element impurities on; analyses of irradiated, determination of trace element amounts by; swelling of, effects of silicon and carbon on; density of pressure sintered ceramic; diffusion coefficients for pressure sintered ceramic; mechanical properties of high temperature oxide
URANIUM OXIDES UO_2—fuel pellets of, results of fluorination of
PLUTONIUM OXIDES PuO_2—fuel pellets of, results of fluorination of
RUTHENIUM—chemistry of, analysis by fluoride volatility technique
ARGONNE ADVANCED RESEARCH REACTOR—reactivity additions to, analog model for hot-spot development caused by
REACTOR SAFETY—accident calculations for 1000 MW(E) reactor, computer code for
REACTOR SAFETY EXPERIMENTS—fuel meltdown studies in TREAT, metallic
REACTOR CONTAINMENT STRUCTURES—safety of, momentum equations in finite difference form for calculation of (M.L.S.)

9989 (BAW-3867-1) FAST BREEDER REACTOR STATIC PHYSICS METHODS DEVELOPMENT AND ANALYSIS PROJECT. Quarterly Technical Report, July-September 1967. Roy, D. H. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Contract AT(30-1)-3867. 38p. Dep. CFSTI.

The design code FARED is described. The compilation, debugging, and modifications made in the ENDF/B service routines are also described. The one-dimensional criticality and depletion code is used to relate the sensitivity of certain fast reactor design parameters to complex physics models. (D.C.C.)

9990 (BAW-1312) 1000-MWe LMFBR FOLLOW-ON STUDY. Quarterly Progress Report, June 1-August 31, 1967.

Mars, D. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Contract 31-109-38-1998. 184p. Dep. CFSTI.

REACTORS, FAST—description of 1000 MW(e) liquid metal-cooled breeder, reference design plant; fuel reloading operation for 1000 MW(e) liquid metal-cooled breeder, description of
REACTORS, LIQUID METAL-COOLED—description of 1000 MW(e) fast breeder, reference design plant; coolant loss in 1000 MW(e) LMFBR, effects of sodium fires in; fuel reloading operation for 1000 MW(e) fast breeder, description of
REACTORS, BREEDER—description of 1000 MW(e) liquid metal-cooled fast, reference design plant; fuel reloading operation for 1000 MW(e) liquid metal-cooled fast, description of
REACTOR FUEL ELEMENTS—design configurations of assembly for 1000 MW(e) LMFBR
REACTOR FUELS—economics of 1000 MW(e) LMFBR, effects of sodium void coefficient on; burnup of 1000 MW(e) LMFBR, effects of central void on
URANIUM OXIDES UO_2, PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, thermal conductivity for 1000 MW(e) LMFBR fuel of, at 0 to 5000°F
PUMPS (LIQUID METAL)—description of 1000 MW(e) LMFBR
HEAT EXCHANGERS (LIQUID–LIQUID)—sodium flow 1000 MW(e) LMFBR, description of
HEAT TRANSFER SYSTEMS—primary system flow temperatures for 1000 MW(e) LMFBR
RADIOACTIVE WASTE—disposal system for 1000 MW(e) LMFBR, description of gas and liquid
SODIUM—cooling system of, effects on reactor safety of fires in
REACTORS, POWER—fuel reloading of 1000 MW(e) liquid metal-cooled fast breeder, description of (D.C.C.)

9991 (BNL–10809) CASE FOR EPITHERMAL BREEDERS. Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). Nov. 1966. 19p. Dep. CFSTI.

Epithermal breeder power reactors are examined from the standpoint of economy—both neutron and financial. Neutron breeding ratios are evaluated; a set of design parameters are given. Power costs are tabulated; each of the composite costs is discussed. (M.L.S.)

9992 (BNL–50027) THE ORDERED-BED FAST REACTOR CONCEPT (1000-MW(e) REACTOR DESIGN). Epel, L. G.; Levine, M. M.; Nugent, G.; Parsick, R. J. (eds.) (Brookhaven National Lab., Upton, N. Y.). June 1966. 37p. Dep. CFSTI.

A description of the Ordered-Bed Fast Reactor (OBFR) is given. Analysis of an efficient fuel system for the OBFR with an ordered bed of UC spheres is presented. The prepared conceptual design for a 1000 MW(e) OBFR describes the estimated fuel cycle cost to be 0.31 mills/kW(e)-hr and the total energy cost to be 3.28 mills/kW(e)-hr with a doubling time of 11 years. (D.C.C.)

9993 (EUR–2762(ANNEX)) INFLUENCE OF IRRADIATION ON ADMISSIBLE WATER IN LEAKAGE IN H.T.G.C.R. Valette, L. J. (Atomic Energy Establishment, Winfrith (England)). 1967. 14p. Dep.

In a high temperature gas cooled reactor of the DRAGON type, the temperature dependence of the radiolytically induced graphite oxidation is such that, for one specified admissible local attack, the water inleakage can be increased. (auth)

9994 (EUR–3482,f) CENTRALE NUCLEAIRE DES ARDENNES. Rapport Annuel 1966. (Ardennes Nuclear Power Plant. Annual Report, 1966). (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-Lez-Givet (France)). June 1967. 37p. (In French). Dep.

The work completed during 1966 on the design and construction of the Ardennes Nuclear Power Plant is summarized. Discussions with the safety divisions are reviewed. The on-site construction and tests included the completion of the reactor with start-up of the reactor on October 18. The financial status of the power plant is reported. (J.S.R.)

9995 (EUR–3638) KERNKRAFTWERK LINGEN. Jahresbericht, 1966. (Lingen Nuclear Power Plant. Annual Report, 1966). (Kernkraftwerk Lingen G.m.b.H. (West Germany)). June 15, 1967. 40p. (In German). Dep.

An account is given of the progress made in the construction of the Lingen nuclear power plant. During the year under review most of the construction work was completed; the assembly work and the manufacture of components by the various suppliers are in an advanced stage. A survey of the construction progress achieved and a time schedule are given. Also reported on are the licensing procedures in respect to atomic law, building law and water law. The labor force employed on the site is shown diagrammatically. A list of the principal contracts concluded and a review of the financing arrangements are presented. Three photographs of the site are included. (auth)

9996 (EUR–3651) TWISTED TAPE BOILING WATER REACTOR. Final Report, July 1965–September 1966. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes (France)). Sept. 15, 1967. 109p. Dep.

Theoretical work about the feasibility and economic interest of a 600 MW(e) Twisted Tape BWR led to the first conclusion that an appreciable gain on the kWh cost can be expected for a core power density of about 60–70 kW/liter. However, before giving a final answer, some technological problems would have to be solved and also more information about basic thermal-hydraulics phenomena should be obtained from further tests. An in-pile experiment of Twisted Tape prototype fuel elements in the Kahl VAK BWR has been prepared. Calculations using both usual CHF correlations and experimental results on TT clusters proved the safety of such an experiment. The bundle has been manufactured with few difficulties and an important technological knowledge about twisted tape clusters manufacturing has been gained. As a first step to solve the technological problems about TT behaviour in a BWR, an out of pile experiment has been conducted on a 9 rod TT bundle with the aim to test its behaviour under corrosion. Satisfactory results, especially about fretting corrosion, allow good behaviour of the twisted tape clusters under actual reactor conditions to be expected. Thermal tests which were not initially foreseen have also been performed at the SET of the EURATOM CCR ISPRA. Critical Heat Flux was measured on a 4 rod bundle with twisted tapes, at inlet conditions (high subcooling) which had never been tested previously. The results are in good agreement with those obtained by SNECMA during former tests. However, since no suitable explanation of them could be given, a new test program has been defined which involves in a closer way the SET of CCR ISPRA. (auth)

9997 (EURFNR–416) CALCULATION OF LARGE FAST REACTORS. Braess, D.; Froelich, R.; Jansen, A.; Kuesters, A.; Schroeter, K. E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Aug. 1967. 28p. (KFK–620; EUR–3689). Dep.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The fundamental procedure used in Karlsruhe for fast reactor calculations is presented. The preparation of multigroup constants, the determination of reactivity coefficients with the calculation of second criticality, and the long-term behavior of fast reactors are discussed in detail. (H.D.R.)

9998 (GA–7932) LOW-TEMPERATURE ADSORPTION STUDIES FOR THE PSC REACTOR. Burnette, R. D.; Lofing, D. R. (General Dynamics Corpp., San Diego, Calif. General Atomic Div.). June 20, 1967. Contract AT(04-3)-633. 20p. Dep. CFSTI.

Laboratory experimental work on adsorption at liquid-nitrogen temperature for the Fort St. Vrain Power Reactor is described. Data on the dynamic and equilibrium adsorption of H_2, tritium, and CO on activated carbon at −196°C are given. In addition, experiments on the effect of high CO impurity levels on the adsorption of Kr are reported. The results indicate that the Langmuir isotherm model is an excellent representation of pure and mixed gas adsorption on activated carbon. (auth)

9999 (GAMD–7374) AN EVALUATION OF THE NEUTRON KINETICS MODEL USED IN THE DESIGN OF THE FORT ST. VRAIN NUCLEAR GENERATING STATION. Dahlberg, R. C.; Merrill, M. H. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 16, 1966. Contract AT(04-3)-633. 7p. Dep. CFSTI.

A method for calculating peak temperature during transients for the Fort St. Vrain Power Reactor is given. The method involves use of a modified adiabatic approximation with a point kinetics model. This method allows a conservative calculation. (M.L.S.)

10000 (HN–190) RELIABILITY ANALYSIS OF NUCLEAR POWER PLANT PROTECTIVE SYSTEMS. Garrick, B. J.; Gekler, W. C.; Goldfisher, L.; Karcher, R. H.; Shimizu, B.; Wilson, J. H. (Holmes and Narver, Inc., Los Angeles, Calif. Nuclear Div.). May 1967. Contract AT(10-1)-205; Subcontract No. C-275. 600p. Dep. CFSTI.

For Phillips Petroleum Co., Idaho Falls, Idaho, Atomic Energy Div.

Data and analytical requirements for a reliability monitoring program in nuclear safety have been identified. A data management system is defined, incorporating a method for equipment and event classification and a plan for data collection. Equipment classification is accomplished by use of a 9-digit generic code which identifies equipment type, environment, and operating load. The event classification provides coded identification of failure mode, effect, and cause, as well as index of accumulated experience. The data collection plan uses a two-step recording process to enable use of existing plant practices and operating staffs. The first step entails in-plant recording of failure or repair data and operating and test data. The second step requires transferral of operating and failure data to coded input for a centralized data bank. Subsequently, data bank processing will convert and report accumulating experience as failure rate and repair data. The accuracy and flexibility of the Automatic Reliability Mathematical Model (ARMM) technique has been increased for evaluation of the reliability of engineered safety systems. A computer program, Systems Analysis by Fault Tree Evaluation (SAFTE-1), has been developed to implement the fault tree concept. Applications of both techniques to sample problems using estimated or available reliability data demonstrate that they provide useful reliability estimates. Results of these applications show that the quality of these estimates is determined more by the analyst's skill than the limitations of the techniques. It is revealed that the questioning and documentation process required in preparation for quantitative reliability estimates is of value in identifying potential trouble spots and suggesting procedural or design changes which can eliminate or reduce the adverse effects of component failures on safety. It is concluded that reliability analysis can contribute to a more quantitative, systems-oriented measure of safety; techniques adequate for safety analysis of nuclear power plants now exist; the data necessary to support these analyses can be obtained through the suggested data management scheme; and the resulting reliability monitoring program can be executed without need for expanding nuclear power plant operating staffs. It is recommended that the reliability monitoring program be instituted in operating nuclear power plants at the earliest possible data to enable the accumulation of data of quality appropriate to reliability analysis of engineered safety systems. (auth)

10001 (IDO-17254) HYDRODYNAMICS DESCRIBING ACOUSTIC PHENOMENA DURING REACTOR COOLANT SYSTEM BLOWDOWN. Rose, Ronald P.; Hanson, George H.; Jayne, Gerald A. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). July 1967. Contract AT(10-1)-205. 39p. Dep. CFSTI.

The potential consequences of a hypothetical loss-of-coolant accident have received major attention in assuring the safety of water cooled and moderated nuclear reactors. In the investigation of loss-of-coolant accidents, the study of the blowdown of pressurized water systems is a major area of investigation. The understanding of the phenomena associated with blowdown, such as the mechanism of flow initiation, is important in the field of nuclear safety technology. As part of the LOFT (Loss-of-Fluid Test) program, a digital computer program BURST-I (Blowdown Under a Rapid Sonic Transient) has been developed for calculating the spatial distributions of pressure, mass velocity, and enthalpy within a PWR primary-coolant system as functions of time during subcooled blowdown. The theoretical basis employed in BURST for calculating acoustic wave propagation and reflection phenomena in a one-dimensional system is presented. Comparisons of the calculated transmission and reflection of acoustic waves at area changes with those predicted by acoustic theory show that these phenomena are treated correctly by the BURST code. BURST calculational results are compared with data from LOFT semiscale blowdown tests. In general, good agreement is shown between BURST results and these experimental data. The application of the BURST-I Digital Computer Program to the entire LOFT primary-coolant loop indicates that the LOFT core may be subjected to cyclic hydraulic loading during the initial portion of the blowdown transient. Although this presentation chiefly concerns subcooled, adiabatic, and frictionless systems, the methods employed in the BURST-I code are capable of treating both subcooled and two-phase systems with heat input and viscous dissipation. 9 references. (auth)

10002 (IITRI-578-P-21-32) STUDIES OF REACTOR CONTAINMENT. Progress Report, August-September 1967. Gallagher, E. V. (IIT Research Inst., Chicago, Ill.). Contract AT-(11-1)-578. 13p. (IITRI-T-6042-32). Dep. CFSTI.

A review of previous transient blowdown tests in a twelve foot driver tube is given; results of current transient blowdown tests are presented. Previous efforts in design and fabrication of force sensors are reviewed; fabrication and calibration are discussed, with calibration results being given. (M.L.S.)

10003 (ITEF-518) REZONANSNOE POGLOSHCHENIE V REAKTORE S OCHEN BOL'SHIM RASSTOYANIEM MEZHDU BLOKAMI. (Resonance Absorption in a Reaction With a Very Large Distance Between the Blocks). Galanin, A. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 22p. (In Russian). Dep.

Designing a gas cooled heavy-water reactor requires lattices with very large pitches. In such lattices the moderating density will be constant across the cell, and therefore the resonance absorption will not change proportionally to the moderator volume of the cell. The dependence of $1 - \varphi$ on the lattice pitch is determined. It is shown that if the ratio of the fuel element volume to the cell one is not smaller than 0.2 and the cell volume is not more than 1500 cm^2 (for the heavy water reactor) then the correction to the lumped part of resonance absorption is not more than 1.5% and to the not-lumped one is not more than 20% (resonance absorption increases). Diagrams of corrections as a function of the cell volume at fixed ratio of fuel element and cell volumes are given. (auth)

10004 (JAT-67-12) ELK RIVER REACTOR SAFETY ANALYSIS MONTHLY REPORT, DECEMBER 1967. (Rural Cooperative Power Association, Elk River, Minn.). 7p. DTIE.

Operations data on Xe and ^{233}Pa buildup during full power operation of Elk River Reactor are given. Critical position of the twelve rod bank during an Xe transient is shown as a function of time. Feed-water temperature effects are discussed. (M.L.S.)

10005 (KFK-568) VARIATION EINIGER WICHTIGER REAKTORPARAMETER BEIM NATRIUMGEKUEHLTEN 1000 MWe SCHNELLEN BRUETER ZUR UNTERSUCHUNG DER BRENNSTOFFKOSTEN UND DES BRENNSTOFFBEDARFS. (Variation of Several Important Parameters for a Sodium Cooled 1000 MeW Fast Breeder). Benndorf, K.; Gupta, D.; Haefele, W.; Heusener, G.; Jansen, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik. Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). July 1967. 17p. (In German). Dep.

The effect of rod burnup efficiency and rod radius on the fuel element cost of a Na-cooled fast breeder reactor with oxide fuel was studied for 1000 MW(e) output. (J.S.R.)

10006 (NAA-SR-12561) PIQUA NUCLEAR POWER FACILITY REACTOR OPERATIONS ANALYSIS PROGRAM. Semiannual Progress Report No. 10, January 1-June 30, 1967. (Atomics International, Canoga Park, Calif.). Nov. 1, 1967. Contract AT(04-3)-701. 109p. Dep. CFSTI.

Topics discussed include: operation history summary; hydraulic testing; coolant flow characteristics and temperature variations; fuel elements overall heat transfer coefficients calculations; fuel element thermodynamics; coke deposition analysis; and analysis of out-of-core deposits. (D.C.C.)

10007 (NAA-SR-Memo-12420(Vol.1)) PIQUA NUCLEAR POWER FACILITY AVAILABILITY EVALUATION REPORT. VOLUME I. Addison, J. V. (Atomics International, Canoga Park, Calif.). Nov. 6, 1967. Contract AT(04-3)-701. 101p. Dep. CFSTI.

The objective of the study was to determine the expected availability and reliability of the Piqua Nuclear Power Facility upon completion of the recovery program modifications. The major modifications are (1) installation of a new control rod system (Mark III) and (2) elimination of the low velocity regions in the core. In addition, the past PNPF operational data were evaluated and a comparison was made between the historical and the expected future performance. The evaluation of various systems of the plant was conducted by use of failure mode and effect analyses, fault tree diagrams, and reliability block diagrams. The analyses indicate that the reliability of the PNPF Systems precludes the necessity of changes to the facility beyond the recovery program modifications to assure a high availability of PNPF. The results indicate that for a three-month operational cycle (1) the PNPF should have an availability of approximately 95%, including time for fuel shifting, as compared with 70% in the past; (2) the control rod circuits should have a reliability of 85.8% for the three-month operating period. The control rod circuits historically had 46 failures in approximately 12,000 hours of operation, but average outage per failure was small and thus the system was able to attain the 70% availability. Results of the analyses are based on the core problems not recurring and on the control rod circuits performing as designed. (auth)

10008 (NAA-SR-Memo-12420(Vol.2)) PIQUA NUCLEAR POWER FACILITY AVAILABILITY EVALUATION REPORT. VOLUME II. RELIABILITY BLOCK DIAGRAMS, MAJOR COMPONENT FAILURE DATA, FAILURE MODE AND EFFECT ANALYSES. Addison, J. V. (Atomics International, Canoga

Park, Calif.). Nov. 6, 1967. Contract AT(04-3)-701. 356p. Dep. CFSTI.

The reliability evaluation and the failure mode and effect evaluation diagrams and tables used in the study to determine the expected operating availability and reliability of the PNPF upon completion of the recovery program modifications are presented. (H.D.R.)

10009 (NP-17084) RAPPORT RORANDE SVERIGES ENERGIFORSORJNING, 1955-1985. (Power Demand and Supply in Sweden, 1955-1985). (Finansdepartementet, Stockholm (Sweden)). 1967. 194p. (In Swedish). Dep.

An estimation of the power demand within communities, industries, passenger and goods transportation, agriculture and defense in Sweden to 1985 was done. The population is predicted to 8.4 millions in 1975 and 9.0 millions in 1985. The forecast of total power supply is 445.5×10^6 Gcal. in 1975 and 721.7×10^6 Gcal. in 1985. The nuclear power supply will be 34.4×10^6 Gcal. and 221.1×10^6 Gcal. respectively. (SWED)

10010 (NP-17126) RAPPORT ANNUEL, 1966. (Annual Report, 1966). (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 46p. (In French). Dep.

The principal studies and programs of the Belgian CEN are briefly reviewed. The study of reactors and the experimental program on fast neutron reactors, gas reactors, light water reactors, and homogeneous reactors are briefly discussed. The Vulcain project in the area of power reactors is briefly outlined. Studies were made on fuel cycles with respect to the fabrication and utilization of Pu enriched fuels, advanced type fuels for fast reactors, and use of burnable poisons in thermal reactor fuels. Basic research was made on the physical characteristics of U oxide and other semiconductors with low mobility, structure faults in metals and ionic crystals, elastic and inelastic scattering of neutrons, low energy physics, radiobiology, cellular biochemistry, and phytobiology agronomy. The production of radioisotopes and labeled molecules and the use of γ radiation sources are given. The health physics and safety precautions are outlined. (J.S.R.)

10011 (ORNL-TM-2034) REACTOR OPERATOR STUDY HANDBOOK (PROGRAMMED INSTRUCTION VERSION). VOLUME II. RADIATION SAFETY AND CONTROL. Costner, R. A. Jr.; Cramer, E. N.; Scott, R. L. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 181p. Dep. CFSTI.

One of five reactor operator training handbooks is presented. The five volumes include, Vol. I—Elementary Mathematics Review, Vol. II—Radiation Safety and Control, Vol. III—Reactor Physics, Vol. IV—Heat Theory and Fluid Flow, Vol. V—Instrumentation and Controls. The method of instruction is explained at the beginning of each volume. This volume covers instruction sections on Atoms, Radioactive Material and Radiation, Ionization, Radiation Units, Health Hazards of Radiation, Radiation Protection Methods, and Radioactive Contamination—Protective Measures. (M.L.S.)

10012 (ORNL-TM-1908(Pt.1)) BEHAVIOR OF FISSION PRODUCTS RELEASED INTO A STEAM-AIR ATMOSPHERE FROM OVERHEATED UO_2 PREVIOUSLY IRRADIATED TO 20,000 MWD/T. Nuclear Safety Pilot Plant Run No. 14, Part I. Parsly, L. F.; Row, T. H. (Oak Ridge National Lab., Tenn.). Sept. 27, 1967. Contract W-7405-eng-26. 44p. Dep. CFSTI.

The results of the first run made in the Nuclear Safety Pilot Plant (NSPP) using Zircaloy-2 clad UO_2 are presented. Fuel was melted in a plasma under reducing conditions with a steam-air atmosphere in the model containment vessel. Behavior of the fission products, which were released, was determined. Fission product deposition on the reactor containment vessel was measured. Prototypes of remotely actuated LOFT samplers were tested. (10 references.) (M.L.S.)

10013 (AEC-tr-6722) DESIGN OF NUCLEAR PLANTS. Komarovskii, A. N. Translation of Stroitel'stvo Yadernykh Ustanovok, Atomizdat, Moscow, 1965. 482p. (IPST-Cat.-1875). Dep. CFSTI.

A book discussing various aspects of design of nuclear power plants is presented. These aspects are covered under five major headings: Relationship Between the Technological and Shielding Properties of Structural Materials including radiation and its biological effects, required properties of materials used for biological shielding, and the effects of the water content of concrete on its protective properties; concrete and other materials for biological shielding including classification of concretes and cements used for biological shields, concretes on standards and extra-heavy aggregates, hydraulic and boron-containing aggregates for concrete, effects of radiation and heat on the mechanical of concretes, design of concrete mixes for radiation shields, economic evaluation of the use of special heavy and hydraulic concretes for nuclear radiation shields, and various materials for biological shielding; structural design of nuclear reactors including siting, location of reactors with respect to ground level, foundations and supporting of structures and biological shields, biological shields of reactors with dry chambers, thermal shields, use of prestressed concretes for reactor structures, water shields for stationary reactors, pool-type reactors, reactor buildings and premises, structures for reactor plants, underground reactor construction, coverings of structures for radioactive areas, pools for storage of radioactive materials; shielding containment of nuclear reactors including purpose of containment, design of containment structures, materials stresses in and structural forces on containment structures, materials and design of containment structures, assembly and construction of nuclear plants, construction of special concrete biological shielding, specific features of construction of reactors, and handling and treatment of special coverings. Appendices contain data on these various topics. 444 references. (M.L.S.)

10014 (ANL-Trans-542) STUDY OF HEAT RELEASE DISTRIBUTION IN FAST REACTORS WITH ABSORBER RODS. Boudarenko, V. V.; Voropaev, A. I.; Zinov'ev, V. P.; Koloskov, B. V.; Polivanskii, V. P.; Troyanov, M. F.; Khalov, E. M.; Zhagalin, N. M. Translated by Elmar K. Willip (Argonne National Lab., Ill.), from Paper Presented at Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany, October 30-November 3, 1967. 13p. (CONF-671043-14). Dep. CFSTI. JCL \$1.60 fs, \$0.80 mf.

The experimental calculation of a fast reactor with a system of absorbing rods in compensation units of burnup to permit increased continuous operation periods is presented. Three assemblies were tested to note effects of configuration on heat fluctuations in the fuel elements. In each assembly the core contained two regions with different concentrations of ^{235}U in the fuel rods, a zone of low enrichment and a zone of high enrichment. The three assembly variations were: homogeneous zones with centrally located boron rods; simulators of control units in "withdrawn" position and one inserted boron rod for a control simulator; and an assembly with a more powerful boron rod to serve as a simulator of the temperature compensator. (D.C.C.)

10015 THREE-ZONAL CALCULATION METHOD OF BOILING HEAVY WATER POWER REACTOR. Studovic, Milovan; Jovanovic, Ljubomir. Nukl. Energ., 3: No. 6, 1-7 (1966). (In Serbo-Croatian).

Specific criteria for making BWR calculations are presented. An alogarithm of calculations is presented, with the original method, for determining the space-dependent thermal and hydraulic core parameters. The reactor core is divided into three zones for calculational purposes; this three zonal division allows extension of the calculational method to superheating reactors. (TSS)

10016 YANKEE REACTOR PRESSURE VESSEL SURVEILLANCE: NOTCH DUCTILITY PERFORMANCE OF VESSEL STEEL AND MAXIMUM SERVICE FLUENCE DETERMINED FROM EXPOSURE DURING CORES II, III, AND IV. Serpan, C. Z. Jr.; Hawthorne, J. R. (Naval Research Labs., Washington, D. C.). J. Basic Eng., 89: 897-910(Dec. 1967).

Charpy V-notch specimens representative of one of the several heats of A302-B steel forming the Yankee reactor pressure vessel, and irradiated as part of the Yankee surveillance program, have been tested by the Naval Research Laboratory. Specimens of this particular heat, irradiated in near-core as well as in vessel wall locations, showed more embrittlement than did specimens of a reference steel heat of the same nominal A302-B composition irradiated simultaneously in the same surveillance capsules. Those specimens from both the Yankee vessel heat and the reference heat irradiated at the vessel wall location depicted a higher damage rate than that for the accelerated location. The cause of this difference in embrittlement response could not be attributed to an effect of cyclic, service irradiation temperatures, but could be traced to a qualitative relationship of thermal to fast (>1 MeV) neutron fluxes. This ratio was in excess of about 9:1 at the vessel wall location versus a ratio less than about 9:1 for the accelerated location. The computation of a maximum service fluence of 1.46×10^{19} n/cm^2 > 0.5 MeV was made possible by establishment of the neutron spectrum at the reactor vessel wall using computer calculations. The maximum fluence derived by this technique compared favorably with another value given by an independently-developed calculated neutron spectrum. The NRL computed service fluence in concert with the embrittlement data projects a maximum transition temperature increase of 265 deg F, a level of embrittlement considered acceptable for the Yankee reactor vessel after thirty fuel cycles of operation at 600 MW(t). (auth)

10017 NUCLEAR ENERGY IN FRANCE. Pascal, Maurice (CEA, Paris). Rev. Fr. Energ., 18: 361-78(May 1967). (In English and French).

A general survey of the development of nuclear energy in France is given. An historic review, current status, and future predictions for uses of nuclear energy are presented. (M.L.S.)

10018 ELECTRICITY FROM THE ATOM: BRITAIN'S SECOND DECADE. Booth, E. S. (Central Electricity Generating Board, London). Atom, No. 134, 299-311(Dec. 1967).

The development and operation of British nuclear power stations from 1956 to 1967 are surveyed under the following headings: introduction; the first decade; progress since 1956 (including heat transfer from fuel elements, prestressed concrete pressure vessels, fault studies, economics of scale, commissioning, the advanced gas-cooled reactor, safety); situation at end of first decade; the second decade (including advanced gas-cooled reactor development potential, exploiting technology of large turbo-alternators, station siting, the fast breeder reactor, other reactor systems); conclusions. (UK)

10019 TIME DEPENDENT COOLANT TEMPERATURE AFTER A STEP INCREASE IN POWER. Kalker, J. J. (Technological Univ., Delft, Netherlands); Kalker-Kalkman, C. M. Nucl. Eng. Design, 6: 5-19(Aug. 1967).

An evaluation is made of the relationship between a step increase in heat generation in a fuel rod of a nuclear reactor and the temperature of a steadily flowing coolant with constant inlet temperature. The heat transfer mechanism is described by a pair of a simultaneous linear partial differential equations. Various approaches to solve these equations are made assuming that there is no radial temperature gradient in the fuel rod. The results of the different methods are then compared. Subsequently one of the methods is applied on the assumption that there is a radial temperature gradient. In order to compare the theoretical outcome with experimental results similar calculations are carried out for the heat generation in an electrically heated steel tube. (auth)

10020 150-mgd DUAL-PURPOSE PLANT FOR THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA. Davis, W. Kenneth (Bechtel Corp., San Francisco); Galstaun, Lionel; Scharpf, Carl. Nucl. Eng. Design, 6: 1-4(Aug. 1967).

Studies of the engineering and economic feasibility of a dual-purpose power and desalination plant capable of producing up to 150-mgd of fresh water and a large block of power for Southern California are summarized. (auth)

10021 HEAT TRANSFER OVER THE SURFACE OF A SPHERE IMMERSED IN A RHOMBOHEDRAL FIXED BED. Wierusz, A. (Inst. of Nuclear Research, Warsaw). Nucl. Eng. Design, 6: 43-56(Aug. 1967).

The local heat transfer in a gas-cooled bed of spheres is described. The thermal boundary layer equation valid for the laminar boundary layer region on the surface of a sphere is presented, together with the conditions of existence of the solution. Numerical solution of the equation was made possible by carrying out experimental measurements of the velocity field around a sphere in the bed. The solution is used to determine local values of the Nusselt number by assuming that heat transfer on the surface of the sphere can be considered as conduction through a stagnant gas layer. The results of the calculations are presented in the form of graphs of constant Nusselt number. (auth)

10022 TWO-DIMENSIONAL, MULTIREGION ANALYSIS OF TEMPERATURE FIELDS IN REACTOR TUBE BUNDLES. Axford, Roy A. (Los Alamos Scientific Lab., N. Mex.). Nucl. Eng. Design, 6: 25-42(Aug. 1967).

A multiregion method for predicting temperature fields in the coolant, cladding and fuel regions of clustered rod tube bundles is developed. Analytical expressions for the circumferential variations of the inside and outside cladding wall temperatures and heat fluxes and of the cladding wall temperature drop are given. Pitch-to-diameter ratios over which single coolant region analyses of energy transport in tube bundles are approximately valid are defined. (auth)

10023 STADE AND WUERGASSEN [NUCLEAR POWER STATIONS]. Nucl. Eng., 12: 756-7(Oct. 1967).

An outline is given of the design of two 600 MW(e) nuclear power stations for North Germany scheduled for operation by 1972. The Stade PWR design, to be built by Siemens, is essentially the same as the Obrigheim plant. The Wuergassen BWR design, to be built by AEG-Telefunken, utilizes jet pumps for circulation; the fuel is expected to reach 27,500 MWd/t. (UK)

10024 DRAGON REACTOR EXPERIMENT. AN INDEPENDENT ASSESSMENT. Henderson, John. Nucl. Energy, 162-7 (Nov.-Dec. 1967).

The history of the cooperative European HTGR project is outlined. The reactor is briefly described, and research and development on fuel elements, graphite, and bearings are reviewed. During the commissioning period problems encountered included He coolant leakage and contamination, fuel behavior, and control rod bowing. Application of the design to future commercial power stations is considered. (UK)

10025 LICENSING AND REGULATION OF NUCLEAR REACTORS. PART 1. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, FIRST SESSION ON LICENSING AND REGULATION OF NUCLEAR REACTORS, APRIL 4, 5, 6, 20, AND MAY 3, 1967. Washington, D. C., Joint Committee on Atomic Energy, 1967. 502 GPO $1.75.

10026 DEVELOPMENT, GROWTH, AND STATE OF THE ATOMIC ENERGY INDUSTRY. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, FIRST SESSION, AUGUST 10, 11, AND SEPTEMBER 8, 1965. Washington, D. C., Joint Committee on Atomic Energy, 1966. 624p. GPO $2.00.

10027 METHOD FOR BURNING A FUEL IN A SUPERHEATING-TYPE REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-16353. Sept. 14, 1966. Filed Aug. 13, 1963.

The method proposed for burning a nuclear fuel is applicable for a reactor in which the thermal-neutron and the fast-neutron multiplication region are combined and coolant flows through the two regions for the boiling and then superheating. The advantages to the method are the elimination of considerable heat-output peakings, burning of a poison-containing fuel in the fast-neutron region, accompanied by the fuel breeding; and burning of an impurities-deposited fuel only in the last stage. Shelves are piled up in the reactor core, and coolant water flows between the shelves entering from one side and leaving from the other in the overall direction of bottom to top of the reactor core. The space, produced by the shelves, is packed with fuel plates. The reactor core is divided vertically in the thermal-neutron region where coolant water is heated; the epithermal-neutron region where it is boiled; and the fast-neutron region where the produced steam is superheated. In the exchange of fuels fresh fuel is loaded in the thermal region, and as the burning proceeds, it is moved into the fast region and finally into the epithermal region. (NSA of Japan)

10028 FAST-NEUTRON REACTOR. Yokomi, Michiro (to Hitachi Ltd.). Japanese Patent 1966-16354. Sept. 14, 1966. Filed Sept. 9, 1963.

An improved, reactor-control fuel element is proposed for the safe operation of large fast reactors. In fast reactors, the reactivity control is usually achieved by inserting or withdrawing reactor-control fuel elements from the reactor core. Since the control element is of the same material as the fuel itself, the fissioning is by fast neutrons, making the reactor somewhat dangerous compared with thermal-neutron reactors. In the fast-neutron reactor proposed a moderator is installed in the passage of a reactor-control fuel element, or in its vicinity, or in the element itself. When the control element is inserted in the reactor core, the fissioning of fissile material in the element takes place mainly by thermal neutrons, slowed down by the (installed) moderator. (NSA of Japan)

10029 REACTOR PRESSURE VESSEL. Hayashi, Tsutomu (to Hitachi Ltd.). Japanese Patent 1966-16358. Sept. 14, 1966. Filed Sept. 12, 1963.

In the proposed reactor pressure-vessel, the evacuation of cooling liquid due to pipe rupture is restricted to only a part of the reactor core. Within the pressure vessel the reactor core is installed in the enclosing cylindrical body. This cylindrical body is partitioned into at least two spaces by the axial plates. Each space, extending from bottom to top of the reactor core, has an entrance and exit for the cooling liquid. These spaces are connected to each other for the appropriate cooling of the reactor core. (NSA of Japan)

10030 SAFETY SYSTEM FOR A NUCLEAR REACTOR. Goko, Hiroshi (to Hitachi Ltd.). Japanese Patent 1966-17798. Oct. 11, 1966. Filed Mar. 10, 1964.

When a failure occurs in a reactor, high enthalpy fluid fills the containment vessel. This fluid is then usually led into the surrounding water pool to condense it into a liquid. Since the cost involved is large due to the size of the pool, an improved system is presented. The reactor is installed in a "dry well," and the water pool surrounds this dry well; the fluid, e.g. vapor (at the time of an accident), is led into the pool from the dry well through a long pipe. A pipe running from within the pool and between the drywell and the pool is installed; both ends of the pipe are open. Thin plates are fixed within the long pipe just above and below the position where the pipe enters, thereby partitioning the long pipe; another thin plate is fixed in the lower part of the pipe (which runs into the long pipe) in a similar manner. The space produced, including the small part of the long pipe and most of the other pipe, is filled with water (from the pool). At the time of an accident, when vapor flows through the long pipe, the plates are destroyed; and water is introduced into the long pipe from the pool, thereby condensing the vapor (from the dry well) during its flowing into the water pool. (NSA of Japan)

10031 BUILT-IN DEVICE FOR PRODUCING SUPER-HEATED STEAM BY NUCLEAR POWER. Horibe, Osamu (to Kawasaki Dockyard Co., Ltd.). Japanese Patent 1966-17120. Sept. 28, 1966. Filed July 27, 1963.

The plant as a whole consists of a pressure vessel and the outer vessel surrounding the pressure vessel. Through the pressure vessel a number of pipes run vertically with their top and bottom being open; the top and bottom of the vessel are closed leaving exposed the openings of the vertical pipes. Within each pipe a fuel rod is inserted with space between the pipe wall and the fuel. The pressure vessel is filled with liquid moderator. Coolant flows through the pipes (inside the pressure vessel) and the space formed between the outer vessel and the pressure vessel. The liquid moderator is boiled in the pressure vessel to produce vapor (steam), which is then led through the coolant outside the pressure vessel by piping in order to superheat the steam. The superheated steam is finally taken out of the outer vessel. (NSA of Japan)

10032 FLOW-THROUGH SUPERHEATING NUCLEAR REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1967-5040. Mar. 1, 1967. Filed Apr. 5, 1963.

In the flow-through superheating reactor proposed, in which the boiling and the superheating are done in the same system, the overall length of cooling-water channels is considerably increased in comparison with the conventional methods. The series of cooling-water channels connected to one another are arranged throughout the reactor core in a spiral (in the cross-sectional view of the reactor core); nuclear fuel is in the coolant passages. From the outer to the inner part, the series is divided into three regions: the boiling of cooling water, evaporation of the remaining water, and the superheating of produced steam. (NSA of Japan)

10033 BOILING LIQUID NUCLEAR REACTOR HAVING TIERED, HORIZONTALLY EXTENDING COOLANT CHANNELS. Hayashi, Tsutomu (to Hitachi, Ltd.). U. S. Patent 3,346,460. Feb. 8, 1965.

A reactor comprising a reactor vessel, a core, vapor-liquid separators disposed on opposite sides of the reactor vessel, and associated coolant channels is described. The core consists of horizontal coolant channels stacked in tiers. The first coolant channel contains a fuel rod, and a second coolant channel closely parallel to the first coolant channel passes through the reactor vessel and into vapor-liquid separators. The coolant inlet is located in the first coolant channel with multiple passages to the second coolant channel. (U.S. Pat. Gazette)

10034 METHOD FOR PREVENTING WATER FLOODING OF THE SUPERHEATING REACTOR CORE. Shimai, Sumi (to Hitachi Ltd.). Japanese Patent 1967-4879. Feb. 28, 1967. Filed Jan. 29, 1965.

By the method proposed, the prevention of water flooding of the superheating reactor-core can be improved and hence the nuclear safety relating to this flooding increased. Advantages include: the compact structure utilizing simple construction and the limited available space, the resulting high economy of the reactor system, and no hindrance to the fuel exchange and control-rod drive. The reactor core consists of the boiling region, having horizontal coolant passages, and the superheating region just above the boiling region, having horizontal steam passages, with both regions contained in the same pressure vessel. The saturated steam from the boiling region flows up along the outside of the superheating region, enters the "superheated-steam" chamber located above the superheating region, and then flows into the superheating region from the chamber. (NSA of Japan)

10035 NUCLEAR REACTOR REFUELLING DEVICE. Aubert, Michel; Brouard, Daniel; Rouge, Pierre (to Commissariat a l'Energie Atomique). U. S. Patent 3,354,041. Nov. 1, 1965. Priority date Nov. 18, 1964, France.

A refuelling device for gas-cooled reactors with fuel element channels formed in the moderator is described. A storage chamber is provided which is separated from the core containment vessel by openings which can be plugged. The fuel loading system consists of a tunnel with a lock-chamber which is connected to the storage chamber by means of a door pivotally mounted on the containment shielding. (U.S. Pat. Gazette)

10036 GAS COOLED NUCLEAR REACTOR. Schmidt, Gerhard (to Gesellschaft fuer Kernforschung mbH). U. S. Patent 3,357,892. Apr. 23, 1965. Priority date Apr. 29, 1964, Germany.

A gas-cooled reactor is described which consists of a high-pressure vessel; an internal reactor core; a heat shield spaced between the core and the inner surface of the high-pressure vessel; a gas-coolant circulating in an annular space between the heat shield and the inner surface of the high-pressure vessel; a pressure conduit to guide gas coolant in the core; a heat exchanger; an exhaust conduit to carry coolant gas from the pressure vessel to the heat exchanger; and a return conduit to carry coolant into the pressure vessel. An additional conduit is provided to carry coolant gas into the pressure vessel in the event of a leak in the main return conduit. (U. S. Pat. Gazette)

10037 NUCLEAR REACTORS. Prince, Michael John; Ainsworth, Geoffrey Douglas (to United Kingdom Atomic Energy Authority). U. S. Patent 3,346,459. July 18, 1966. Priority date July 28, 1965, Great Britain.

A reactor is described which contains a fuel rod cluster, perforated guide tubes interspersed among the fuel rods, control pins insertable with clearance into the guide tubes, an operating assembly for inserting and withdrawing the control pins, and fluid coolant conduit for control pin operating assembly. After the coolant passes over the operating assembly guide tubes, it is sprayed over the fuel rods. (U. S. Pat. Gazette)

10038 LIQUID MODERATED, LIQUID COOLED NUCLEAR REACTOR INSTALLATION. Blackburn, Robert William; Brown, William Marriott; Adams, Edward James (to Canadian General Electric Co., Ltd.). U. S. Patent 3,357,889. Aug. 2, 1965. Priority date May 29, 1965, Canada.

A liquid-moderated, liquid-cooled reactor with an upper calandria portion and a lower moderator dump tank portion is described. The calandria portion is separated from the moderator dump portion by a transverse wall, and the calandria consists of multiple fuel tubes with one end of each extending outside the reactor vessel through a window plate. Pressurized gas in the moderator serves to hold coolant in the calandria. A water filled vault surrounding the reactor vessel provides cooling and shielding. The fuel tube window has additional shielding from parallel plates mounted between the window and the calandria. (U. S. Pat. Gazette)

10039 NOZZLE DEVICE IN FLOW TUBES OF A NUCLEAR REACTOR OF THE BOILING WATER TYPE. Wadmark, Lars Olof Tor (to Aktiebolaget Atomenergi). U. S. Patent 3,357,891. June 11, 1965. Priority date June 25, 1964, Sweden.

An improved fuel tube design for boiling water reactors is described. A nozzle is placed in the upper portion of the vertical fuel tubes and is connected to a conduit for alternate steam discharge and cooling water entrance flow. The lower end of the nozzle consists of a tube which opens directly over the fuel, and the upper end of nozzle contains at least one opening for discharging steam from the fuel tube. (U. S. Pat. Gazette)

10040 PROCESS FOR POWER PRODUCTION. (to Commissariat a l'Energie Atomique). French Patent 1,408,858. Sept. 26, 1966. Filed May 14, 1965.

A nuclear reactor is moderated by a liquid and cooled by CO_2 gas which circulates in a closed circuit. The CO_2 is successively compressed in two stages from about 35 to 160 bars, preheated in a first and a second heat exchanger, expanded in a high-pressure turbine to a pressure of about 80 bars, heated in the reactor to a temperature of 520°C, expanded in a low-pressure turbine, and cooled in the second heat exchanger. The first heat exchanger is supplied by the liquid moderator and is connected in parallel or in series with the second heat exchanger. (I.I.B.)

10041 FUEL HANDLING DEVICE FOR A GAS-COOLED REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,414,864. Sept. 13, 1965. Filed Sept. 1, 1964.

The device is mounted within the reactor vessel and comprises a radial arm which rotates around an axis parallel to the vertical reactor channels. The radial arm is supported on a central gas-cushion bearing and on a terminal gas-cushion bearing which are supplied with gas through a pipe carried by the radial arm. Means are provided to displace a fuel element handling machine along the arm. (IIB)

10042 PROCESS FOR POWER PRODUCTION. (to Commissariat a l'Energie Atomique). French Patent 1,408,858. July 12, 1965. Filed July 8, 1964.

Pressurised CO_2 gas is used to cool a nuclear reactor and to drive directly at least one gas turbine. The CO_2 gas is successively compressed in two stages to attain a pressure in the range of 120 to 250 bars, preheated in a heat exchanger, expanded in a high-pressure turbine to a pressure in the range of 40 to 120 bars, heated in the reactor to a temperature of 520°C, expanded in a low-pressure turbine to a pressure above 15 bars, and cooled in the heat exchanger. (IIB)

10043 ENRICO FERMI REACTOR: USE FOR IRRADIATION TESTING. HEARING BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, SECOND SESSION ON ENRICO FERMI REACTOR: USE FOR IRRADIATION TESTING AND BACKGROUND INFORMATION, APRIL 5, 1966. Washington, D. C., Joint Committee on Atomic Energy, 1966. 276p. GPO $0.70.

10044 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1966. PART 2. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, FIRST SESSION ON REACTOR DEVELOPMENT PROGRAM (EXCLUDING CIVILIAN POWER PROGRAM), FEBRUARY 8, 9, 10, AND APRIL 8, 1965. Washington, D. C., Joint Committee on Atomic Energy, 1965. 506p. GPO $1.50.

10045 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1965. PART 2. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-EIGHTH CONGRESS, SECOND SESSION ON REACTOR DEVELOPMENT, FEBRUARY 5, 6, 18, 19, 20, AND MARCH 4, 1964. Washington, D. C., Joint Committee on Atomic Energy, 1964. 843p. GPO $2.50.

10046 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1968. PART 2. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, FIRST SESSION ON REACTOR DEVELOPMENT PROGRAM, MARCH 14 AND 15, 1967. Washington, D. C., Joint Committee on Atomic Energy, 1967. 897p. GPO $2.75.

10047 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1967. PART 2. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, SECOND SESSION ON REACTOR DEVELOPMENT (CIVILIAN POWER; COOPERATIVE POWER; AND AEC CONTRACTOR TESTIMONY ON REACTOR DEVELOPMENT PROGRAM), FEBRUARY 16, 17, MARCH 3, 15, AND 16, 1966. Washington, D. C., Joint Committee on Atomic Energy, 1966. 505p. GPO.

10048 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1966. PART 3. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, FIRST SESSION ON REACTOR DEVELOPMENT PROGRAM (CIVILIAN POWER PROGRAM), MARCH 11, 18, 19, 24, AND APRIL 13, 1965. Washington, D. C., Joint Committee on Atomic Energy, 1965. 649p. GPO $2.00.

10049 POWER REACTOR TECHNOLOGY AND REACTOR FUEL PROCESSING. Volume 10, Number 2. Dutton, James J.; Lennox, David H.; Brown, Karl K.; Royal, Joseph; Gold, Raymond; Schmeh, Barbard A. (eds.). One of the Five Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Argonne, Ill., Argonne National Lab., Spring 1967. 87p. GPO $0.70 Domestic, $0.90 Foreign.

Separate abstracts were prepared for 14 sections. (M.O.W.)

For abstracts of individual sections see: 8185–8189, 8331, 8421, 8698, 9138, 10050, 10051, 10054, 10056, and 10089.

10050 NEUTRONIC ASPECTS OF PLUTONIUM RECYCLE IN THERMAL REACTORS. Kier, Philip H. Power Reactor Technol. Reactor Fuel Process., 10: 93-101(Spring 1967).

Use of Pu in thermal reactors is summarized. Lattice measurements for Pu recycle physics calculations are presented; a tabulation of measurements in the PRCF, EBWR, CRX, SCORPIO, HECTOR, PRTR, and PDP is given. Comparisons of computer codes for calculations of physics parameters are made. Batch irradiation experiments performed in the EBWR, Saxton, and PRTR are discussed. Economic considerations are presented. 78 references. (M.L.S.)

10051 ELECTRICAL PENETRATIONS OF REACTOR CONTAINMENT BUILDINGS. Verber, Fred. Power Reactor Technol. Reactor Fuel Process., 10: 122-35(Spring 1967).

A discussion of the problems involved with electrical penetrations of containment vessels is discussed. Sources of leakage, low-leakage cable materials, seal-design principles, and leak testing are considered briefly. Penetration schemes are presented for the EBWR, Dresden 1, EBR-2, N. S. Savannah, Fermi, BONUS, Peach Bottom, La Crosse, FARET, San Onofre, and Dresden 2 are shown. 24 references. (M.L.S.)

10052 FAST NUCLEAR REACTOR, COOLED BY A LIQUID METAL. (to Commissariat a l'Energie Atomique). French Patent 1,462,237. Nov. 7, 1966. Filed July 22, 1965.

Tubular boxes, containing the fuel material, are disposed in a reactor vessel. One or more neutron absorbent elements are disposed above the fuel material on the level of the outlet pipes of the liquid metal. These elements occupy a fraction of the section of the tubular box. Upon these elements are placed an absorbent mass of the same area as the tubular box. When the boxes are arranged in the vessel, the absorbent masses form a continuous screen against the upwards loss of neutrons from the core. (IIB)

Marine and Portable Power Reactors

Refer also to abstracts 8739, 8743, and 8745.

10053 (JPRS-43550) OPERATING EXPERIENCE OF SHIPS WITH ATOMIC POWER PLANTS. Mitsevich, A. T.; Muchnik, L. N. Translated from pp 7-23; 31 of Suda s Atomnymi Energeticheskimi Ustanovkami, Moscow, 1967. 20p. CFSTI.

The design and operating experience of the Soviet atomic icebreaker Lenin are briefly described. Safety aspects of the hull design and compartmentation and operating reliability of the reactor plants and propulsion equipment are emphasized. (H.D.R.)

Process Heat and Desalination Reactors

Refer also to abstract 8255.

10054 MULTIPURPOSE NUCLEAR REACTOR SYSTEMS FOR THE PROCESS AND METALLURGICAL INDUSTRIES. Marchaterre, John F. Power Reactor Technol. Reactor Fuel Process., 10: 118-21(Spring 1967).

Use of nuclear power plants for supplying power to associated process and metallurgical industries is discussed. Industries which are preferable for associating with power-desalting complexes are listed; production yields and costs are tabulated. 8 references. (M.L.S.)

10055 PROPOSED LARGE-SCALE COMBINATION NUCLEAR POWER-DESALTING PROJECT. HEARING BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, SECOND SESSION (H.R. 17558 AND S. 3807), SEPTEMBER 14, 1966. Washington, D. C., Joint Committee on Atomic Energy, 1966. 114p. GPO $0.35.

10056 DESALTING WITH NUCLEAR POWER: A PERSPECTIVE. Gast, Paul F. Power Reactor Technol. Reactor Fuel Process., 10: 111-17(Spring 1967).

The use of reactors for desalting and power production is summarized. Characteristics of the BWR, HWOCR, HTGR, and EBR are outlined with respect to desalination. Representative design data for 10,000 MW(t) dual-purpose reactors are given; operating costs are tabulated. Siting problems are discussed briefly. 18 references. (M.L.S.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 8316, 8368, 8686, 8693, 8706, and 8744.

10057 (ANL-7336) ANALOG ANALYSIS OF FLOW REVERSAL AND WATER-HAMMER PRESSURE IN A TYPICAL CLOSED AARR HYDRAULIC RABBIT-TUBE FACILITY. Rohde, Raymond R.; Winiecki, Alan L. (Argonne National Lab., Ill.). Aug. 1967. Contract W-31-109-eng-38. 23p. Dep. CFSTI.

The transient conditions imposed on the hydraulic rabbit and the associated piping systems were investigated to aid in the selection of design parameters for a closed system (i.e., independent of the reactor primary system) for irradiation experiment sample insertion and removal in the Argonne Advanced Research Reactor (AARR). The water-hammer pressures and the rate of change of coolant flow, during the flow-reversal process, were analyzed for a typical AARR rabbit-tube system using an analog-computer system. The system characteristics, development of the mathematical model, and results recorded from the analog model are presented and discussed. (H.D.R.)

10058 (INR-P-815/IX/R) THE RELATION BETWEEN THE STABLE REACTOR PERIOD AND THE PROMPT NEUTRON TIME CONSTANT IN THE "ANNA" REACTOR. Chwaszczewski, S.; Mikulski, A. T.; Jablonski, K. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 19p. Dep.

The relation between the stable reactor period and the prompt neutron time constant is discussed for a complicated reactor system. From a theoretical point of view it is shown that this relation may be practically described by the inhour equation. To confirm this conclusion, measurements were taken at the ANNA critical assembly. For pulsed measurements of the prompt time constant near the critical state, a special device for the decrease of delayed neutron background was constructed. It is shown that the prompt reactor period in a critical state can be determined more accurately by simultaneous measurements of the prompt time constant and the stable reactor period. (auth)

10059 (JEN-173-DMe/I-14) MONTAJE DE LOS ELEMENTOS COMBUSTIBLES PARA LA EXPERIENCIA EXPONENCIAL DEL PROYECTO D.O.N. (Fuel Elements Assembling for the DON Project Exponential Experience). de Anca Abati, R. (Junta de Energia Nuclear, Madrid (Spain). Division de Metallurgia). 1966. 45p. (In Spanish). Dep.

The fuel elements used in the DON exponential experiments, the fabrication facilities and equipment, and the fabrication procedures are described. The 74 elements each contain 19 cartridges loaded with sintered UO_2 and UC and In, Au, and Mn probes. The fuel elements were arranged in calandria-like tubes and a process tube. The process tube contained a cooling liquid simulating the reactor organic coolant. The elements were also used in critical assays by the substitution method in the French Reactor Aquilon II. (auth)

10060 (ORNL-4170, pp 162) FUEL ASSISTANCE AND PROCUREMENT. Beaver, R. J. (Oak Ridge National Lab., Tenn.).

A program is described that helps the AEC in problems related to procurement of fuels for research reactors, such as the ETR, the ATR, the AF-NETR, and various Army reactors. (auth)

10061 (ORNL-TM-2078) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT: JULY-SEPTEMBER OF 1967. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). Nov. 13, 1967. Contract W-7405-eng-26. 26p. Dep. CFSTI.

A major problem, breakage of control-plate bearing lugs, was encountered this quarter. The first breaks were noted at the end of cycle 14. Modifications were made to the bearings and their tracks, but additional breaks occurred in cycle 15. Investigation of this problem resulted in only 32.4% reactor operating time this quarter. The primary coolant system was partially decontaminated of its accumulated load of transuranium elements by the addition of $La(NO_3)_3$ to the water. (auth)

10062 (ORNL-TM-2087) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JULY-SEPTEMBER 1967. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). Dec. 5, 1967. Contract W-7405-eng-26. 32p. Dep. CFSTI.

An operations history of the ORR is given. Shutdowns and power reductions are tabulated. Maintenance and change of reactor instrumentation or controls systems are tabulated. A complete fuel cycle history is given. Uses of reactor test holes are explained. Noise analysis experiments, reactivity worth measurements of one of the experiments, flux measurements in the F-3 facility, and shim-rod worth measurements are outlined. (M.L.S.)

10063 (RCN-62) THEORETICAL AND EXPERIMENTAL DETERMINATION OF THERMAL-NEUTRON GROUP CONSTANTS IN REGULAR LATTICES AND A PROGRAMME DESCRIPTION OF THE CODE SATAN. Stamm'ler, Rudi J. J.; Tas, Aldert (Reactor Centrum Nederland, Petten). Apr. 1967. 88p. Dep.

Presented are the results of a comparison between measurements and calculations of thermal group constants in regular H_2O, D_2O, and H_2O/D_2O moderated lattices. Two of the more sophisticated calculational procedures, K-7 THERMOS and MICROFLUX, are outlined and compared to the faster methods DATAPREP-II and SATAN. The SATAN program is described and shown to produce results that compare favorably with THERMOS results. The rolled wire, pin, extrapolation, sector foil, spectrum index screen, and fission track experimental methods to provide information about the spatial variation of the neutron density, the neutron spectrum, and the fission density inside the fuel of a unit cell are briefly discussed. Two cold, clean single pin lattices moderated by H_2O, D_2O, and H_2O/D_2O are used to test the theoretical and experimental methods, and the results show satisfactory agreement. (H.D.R.)

10064 (RT/ING-(66)26) MODALITA DI ESECUZIONE DEL CANALE PASSANTE RELATIVO AL PROGRAMMA PER L'AUMENTO DI POTENZA DEL REATTORE TRIGA AD 1 MW. **(Modification of the Bypass Channel Relative to Increasing Power of the Triga Reactor to 1 MW). Florita, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 63p. (In Italian).** Dep.

A tangential bypass channel was constructed for low γ background studies. The topographic procedures for locating the channel are described. The construction of the channel is then described and illustrated. (J.S.R.)

10065 (SC-RR-67-802) NEUTRON KINETICS OF A REFLECTED FAST BURST REACTOR. Coats, Richard L. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 24p. Dep. CFSTI.

The analytical and experimental investigation of the effect of neutron reflectors on the kinetic behavior of the Sandia Pulsed Reactor is described. A mathematical model which permits the accurate prediction of this effect is presented. 13 references. (auth)

10066 (AERE-Trans-1074) NEUTRON GUIDES: A REPORT ON THE PRESENT STATE OF DEVELOPMENT. Alefeld, B.; Christ, J.; Kukla, D.; Scherm, R.; Schmatz, W. (Kernforschungsanlage, Juelich (West Germany)). Translated by M. C. Wilson for Atomic Energy Research Establishment, Harwell, Eng., from report JUL-294-NP. 45p. Dep. CFSTI. JCL $4.60 fs, $1.55 mf.

It is stated that for neutrons of wavelength λ = 4 Å and longer, neutron guides are the most suitable beam tubes. Their many advantages include a favourable aperture angle. It is shown that for good angular resolution experiments neutron guides are also favourable for the range 0.5 to 2 Å, since losses can be kept to about 30%, with reasonable care. For diffraction experiments with 2- and 4-Å neutrons, a double curved neutron guide with small losses (30%) is described, which suppresses higher orders. Because of the length of this guide (about 100 m), new time-of-flight methods are possible. The theory is discussed, together with technical difficulties. (UK)

10067 EXPERIMENTAL STUDIES OF MICROPARAMETERS OF CLUSTERS OF SEVEN NUCLEAR SUPERHEAT REACTOR FUEL RODS. Wajima, J. T.; Yamamoto, H.; Kikuchi, H.; Ohnishi, T.; Kobayashi, S. (Hitachi, Ltd., Japan). Nucl. Sci. Eng., 31: 19-31(1968).

The microparameters, including the thermal-neutron disadvantage factor, DF, the epi- to sub-Cd neutron capture ratio in ^{238}U, ρ^{28}, the epi- to sub-Cd fission ratio in ^{235}U, δ^{25}, and the ratio of the epi-Cd ^{238}U fission to the sub-Cd ^{235}U fission, δ^{28}, were measured in the Ozenji Critical Facility for a seven-rod clustered nuclear superheat fuel element. The factors, f, p, and ϵ were derived therefrom and the effect of ^{235}U epithermal fissions on the neutron multiplication factor was observed. Flooding changed the individual factors. The maximum discrepancies between measurement and calculation are 1 to 3% for DF, ρ^{28}, δ^{25}, and δ^{28}; 0.3% $\Delta k/k$ for f, p, and ϵ; and 0.4% $\Delta k/k$ for the infinite multiplication factor. When performing the cell calculations, care was taken to determine how to cylinderize the unit cell to perform the one-dimensional calculations with the THERMOS code, how to select the value of the L factor to be used in the JUPITER code (modified MUFT) and how to incorporate the heterogeneous effect of fast fissions. 22 references. (auth)

10068 CORRELATION FOR THE MINIMA IN THE PRESSURE DROP VERSUS FLOW-RATE CURVES FOR SUB-COOLED WATER FLOWING IN NARROW HEATED CHANNELS. **Whittle, R. H.; Forgan, R. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Eng. Design, 6: 89-99(Aug. 1967).**

Measurements have been made in PLUTO of the pressure drop due to forced convective flow of sub-cooled water in narrow heated channels near atmospheric pressure. A correlation for the minima of these curves is presented as an aid to the preliminary assessment of the conditions under which excursive-flow instability can take place. A possible basis for a more general criterion for assessing the locus of the pressure-drop minima is also presented. (auth)

10069 THEORETICAL ANALYSES OF HOMOGENEOUS PLUTONIUM CRITICAL EXPERIMENTS. **Richey, C. R.**

(Battelle Memorial Inst., Richland, Wash.). Nucl. Sci. Eng., 31: 32-9(1968).

A computational analysis was made for the large number of available critical experiments with hydrogenous mixtures. The calculations were made using both multigroup S_4 and diffusion theory with 18 energy groups obtained with the GAMTEC-II code. Resonance capture by the isotope ^{240}Pu was treated in the NR and NRIA approximations. The results are given as a parametric survey for Pu densities ranging from 0.015 to 1.0 g/cm^3. The calculated minimum critical mass of ^{239}Pu is 547 g for water-reflected aqueous $Pu(NO_3)_4$ solutions and 531 g for similar mixtures of ^{239}Pu and water. 14 references. (auth)

10070 DEVICE FOR COOLING A HORIZONTAL EXPERIMENTAL HOLE IN A RESEARCH REACTOR. Nakai, Yasushi (to Mitsubishi Atomic Power Ind., Inc.). Japanese Patent 1966-19520. Sept. 12, 1966. Filed June 14, 1963.

The experimental-hole cooling device proposed is used in the type of reactor in which heavy water as coolant, moderator, and reflector is filled in the central tank with the reactor core, light water as secondary reflector is in the surrounding concentric tank, and a horizontal penetration with an experimental hole running through it is located through the outer concrete shield and the light-water tank to the wall of the central heavy-water tank. Light water to cool the heated top of the experimental hole flows through the space between the wall of the experimental hole and of the penetration. By the proposed method, insufficient cooling of the hole due to the narrow space between the walls is eliminated. To improve the flow of coolant through the space, two large pipes, joining to each other in the shape of a V, are installed at the top of the experimental hole, connecting to the space between the two walls. (NSA of Japan)

10071 METHOD FOR DRIVING A REACTOR CONTROL ROD. Motomiya, Kimio (to Hitachi Ltd.). Japanese Patent 1967-5959. Mar. 10, 1967. Filed Sept. 5, 1964.

By the method proposed, the time lag at the reactor scram can be reduced considerably, particularly in such reactors as MTR, compared with the conventional hydraulic technique. The following procedure is employed in the reactor control-rod drive mechanism where the hydraulic technique is used either directly or as an auxiliary. A surge tank, having an (gas) exhaust valve which opens earlier than the scram drain valve, is installed in the path of water drainage. This surge tank is normally filled with high-pressure gas. By releasing this gas from the tank, the pressure under the piston (in the cylinder) for a control rod is removed. In this way, the control rod is in the state of entering the scram, before the scram drain-valve is opened. (NSA of Japan)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 8248, 8252, 8281, 8293, 8363, 8407, 8421, 8702, 8704, 8715, 8716, 8754, 8805, 8807, 8809, 8810, 8815–8818, 8823, 8845, 9756, 9989.

10072 (ANL–7162) STRESS ANALYSIS OF A REACTOR CORE SUPPORT STRUCTURE CONSISTING OF TWO INTERCONNECTED MULTIREGION PLATES. Marchertas, A. H. (Argonne National Lab., Ill.). June 1967. Contract W-31-109-eng-38. 85p. Dep. CFSTI.

A general method is presented for the stress–deflection solution of a typical nuclear-reactor core support structure. The structure under consideration consists of two axisymmetric multiregion plates, located one above the other and interconnected by concentric rings of tubes. This main body of the structure is supported at the outer circumference, or at some intermediate radius, by circular cylindrical shells. Loading of the structure may be twofold: static transverse pressure on the plane of the plates or the shell walls, and steady-state temperature gradients, both along the radius and across the thickness of the plates and the shells. This loading could be different for the two plates, their individual regions, and the separate shells. Plates with perforations of triangular configuration may also be included in the list of region properties to be considered. Solution to this composite structure problem is obtained by mathematical superposition of elementary thin-plate, circular-cylindrical-shell, and simple beam problems. This is accomplished by the matrix-inversion procedure to solve the resulting simultaneous equations. Results are presented in the form of a matrix, giving the expressions for the coefficients in terms of the design variables. Special effort is taken to make the results particularly suitable for computer programming. (auth)

10073 (ANL–7322) CONTROL AND STABILITY ANALYSIS OF SPATIALLY DEPENDENT NUCLEAR REACTOR SYSTEMS. Hsu, Chun (Argonne National Lab., Ill.). July 1967. Contract W-31-109-eng-38. 81p. Dep. CFSTI.

A fundamental approach to the study of the dynamics of spatially dependent nuclear reactor systems is developed. This approach treats reactor dynamics problems from the system's partial-differential equations without finding the solution or engaging any approximation to a lumped-parameter model. A dynamical model of a spatially dependent process in nuclear reactors is formulated. The model is general and may include the spatial effects of deterministic processes such as control devices and temperature. The extended method of Liapunov, for distributed parameter systems, is then employed to analyze the stability of the system formulated above. A method of using the well-known spectral theory of Von Neumann is also introduced to analyze certain classes of linear and/or nonlinear spatially dependent dynamical systems. The application of the maximum principle to the optimal control system design for spatially dependent reactor systems is demonstrated for several classes of optimization problems. The practicality of optimal control for nonlinear systems is discussed, and a practical technique for suboptimal control design for nonlinear reactor systems using Liapunov functionals is introduced. 47 references. (auth)

10074 (EUR-3637i) INDAGINE TEORICA SUL METODO DELLA REATTIVITA NULLA (PCTR). (Theoretical Research on the Nil Reactivity Method (PCTR)). Ghilardotti, G.; Montagnini, B.; Vigliano, E. (Societa Nazionale Metanodotti, Milan (Italy). Laboratori Reuniti Studi e Ricerche). Nov. 1967. Contract 086-65-12 TEGI. 144p. (In Italian). Dep. CFSTI.

Validation of the zero reactivity method applied to natural U and graphite lattices is presented. Problems encountered include: influence of the spectrum on the quantity of poison that produces a zero reactivity variation; spectral adjustment criteria; internal buffer poisoning; most suitable choice of spectral index; flux flattening in the test zone; and correction for N_2 absorption. (auth)

10075 (EURAEC–1929) USE OF PLUTONIUM AS FUEL IN NUCLEAR REACTORS. Quarterly Report No. 14. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium). Societe Belge pour l'Industrie Nucleaire, Brussels). July 1967. 79p. (EUR–3755). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A last series of fuel rods for neutronic tests of the 3% ^{235}U–1% plutonium type was produced from the balance of the powders of this type recuperated from the previous series. Preparation was started on the group of fuel rods containing 2% ^{235}U and 2.7% plutonium for the same nuclear physics program. A systematic study was made of different types of fixing grippers for rods to be filled by pneumatic vibration, on conclusion of which a very special type was chosen and is being finally perfected. In the production of fuel rods for future irradiation runs in a hydraulic conveyor, the study undertaken as a result of the difficulties encountered when welding the second plugs proved that the piston was responsible for cracking. Ceramographic examination of the fuel rods irradiated during the 4th irradiation run in the BR2 hydraulic conveyor is continuing. It was confirmed by the deformation of the central hole that there has probably been a downward displacement of matter in fusion. A method of obtaining "α" autogammagraphs was perfected on the rods in this run. A 5th irradiation run in the BR2 hydraulic conveyor was initiated. The 3rd boiling water capsule was unloaded after an effective irradiation of 115 days. According to the results at present available, the average power generated in the top part of the heterogeneous test piece would be 300 W/cm. When the appliance was dismantled, considerable cracking was found on the tube-can of the cross. The cause would probably be the precipitation of chromium carbides at the austenitic grain boundaries due to the slow cooling of the tube when the cross was brazed. The following theoretical work was carried out: application of the four PANTHER code options to UO_2 and UO_2-PuO_2 lattices with different plutonium enrichments and isotopic compositions; application of the PANTHER code to the calculation of the boron lattices; the arrangement of the secondary Cadhilac model to take into consideration a mixture of moderators and the burn-up sub-routine of the Panther code for monitoring the reactor by the fraction of light water in the heavy water; and coupling of the PANTHER and PENDULE codes. The VENUS installation was made critical on 9th June 1967 with a cylindrical core of 4% ^{235}U enriched UO_2 rods with a 1.84 cm. square pitch. Treatment of the data arising from the sub-critical tests on VENUS/Vulcain fuel was continued, as was the interpretation of the pulse measurements by research into a type of calculation taking the space variation of reactivity measurements into account. It was assumed for the definition of the reference concept that the plutonium recycled will come from the retreatment of the fuel in the 2nd layer of the SENA core and that this recycling will take place when the 7th layer of the core is loaded. Taking into account the quantity of plutonium available, it will be mixed with the enriched uranium from the same retreatment, in such a way as to reduce to a minimum the hot points on the interface between the fresh uranium enriched fuel and the plutonium-containing rods. The references solution retained provides for the recycling of uranium enriched with 1.75% ^{235}U and 2.6% Pu$_f$. Within the mathematical study of the concept, the calibration of the PANTHER code and the orientation calculations effected at CETIS by means of the GAMBLE and CONDOR codes at present make it possible to proceed with a first series of calculations to find a reference solution for plutonium recycling in SENA. (auth)

10076 (GA-7097(Suppl.)) PRESTRESSED CONCRETE REACTOR VESSEL MODEL 1 SUPPLEMENTAL REPORT. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 30, 1967. Contract AT(04-3)-167. 207p. Dep. CFSTI.

Results of overpressure tests on the first model of the prestressed concrete reactor vessel (PCRV) are presented. Overpressure effects on the various PCRV components are tabulated; these include the liner, PCRV tendons, prestressing bars (rebars), and the concrete, itself. Strain curves for the various components are shown. (M.L.S.)

10077 (GA-7920) GAF AND GAR: NEW COMPUTER PROGRAMS FOR THE CALCULATION OF NEUTRON SPECTRA, TREATMENT OF RESONANCE EFFECTS, AND AVERAGING OF GROUP CROSS SECTIONS FOR FAST REACTOR ANALYSIS. Shanstrom, R. T.; Stevens, C. A.; Archibald, R. J.; Wagner, M. R.; Mathews, D. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Mar. 31, 1967. Contract AT-(04-3)-167. 11p. (CONF-670501-14). Dep. CFSTI.

From International Conference on Research Reactor Utilization and Reactor Mathematics, Mexico City, Mex.

Descriptions of the GAF, GAND, and GAR computer code are presented. The computer programs are used for the calculation of neutron spectra, treatment of resonance effects, and averaging of group cross sections for fast reactor analysis. GAF consists of a numerical solution of the B_1 approximation to the time-independent Boltzman neutron-transport equation. The GAR code also consists of a numerical solution of the B_1 equations but differs from GAF in that all neutron scattering is assumed to be elastic and isotropic in the center of mass coordinate system. The GAND code converts data from ENDF/B format data tape to formats of GAF and GAR, and preaverages any data needed. 12 references. (D.C.C.)

10078 (NAA-SR-Memo-12319) THE TSN COMPUTER PROGRAM FOR SPATIALLY DEPENDENT REACTOR KINETICS CALCULATIONS. Rhoades, W. A.; Morgan, J. G. (Atomics International, Canoga Park, Calif.). Apr. 18, 1967. 74p. Dep. CFSTI.

A computer program to perform spatially dependent kinetics calculations is described. The neutron flux calculation is performed using a 2-group time-dependent S_n solution of the transport equations. Spatially dependent changes in cross sections and density due to temperature changes are treated. Both tabular and graphical output are provided. The program has been successful in simulating transients in SNAP reactors. Experience with other classes of problems has been minimal, but the program is thought to have broad potential application. (auth)

10079 (NAA-SR-Memo-12490) SAFE: A THREE-DIMENSIONAL MONTE CARLO CODE FOR NUCLEAR SAFETY STUDIES. Levitt, L. B. (Atomics International, Canoga Park, Calif.). July 28, 1967. Contract AT(04-3)-701. 17p. Dep. CFSTI.

The SAFE code is a 3-dimensional Monte Carlo code specifically designed to handle criticality problems arising from the flooding of stored or packaged fuel elements. Its features include the use of three cartesian coordinate systems and a special geometric treatment of partial flooding. The use of three coordinate systems is made possible by restricting arrays of rods and boxes to each contain identical individual members. The result is a streamlining of input preparation and improved calculational speed. The HWOCR-SAFE code is an offshoot of the SAFE code specifically designed as a thermal reactor analysis design tool for HWOCR type lattice configurations. Comparisons with multigroup transport calculations have shown it to be an effective benchmark calculation for reactor design purposes. (auth)

10080 (NAA-SR-Memo-12491) CALCULATING PERTURBATIONS OF BURNUP HISTORIES. Vaughan, E. U.; Berland, R. F. (Atomics International, Canoga Park, Calif.). July 28, 1967. Contract AT(04-3)-701. 18p. Dep. CFSTI.

Perturbation theory is applied to burnup calculations. Lagrange multipliers are used to represent the adjoint fluxes in order to deal with the nonlinearity of the burnup. A two-group point-burnup model is constructed; a computer code, ARIADNE-1, is developed. This code calculates burnup history and then determines adjoints to allow prediction of response to perturbations. (M.L.S.)

10081 (NYO-9714) NUCLEAR SAFETY DESIGN OF FUEL FABRICATION PROCESSES. Lees, W. L.; Vachon, L. J. (Nuclear Metals, Inc., Concord, Mass.). Mar. 17, 1961. Contract AT(30-1)-1565. 188p. Dep. CFSTI.

Nuclear safety requirements common to all handling of nuclear fuels are discussed to serve as a guide for the design of fuel element fabrication processes. The basic principles of criticality are presented for both isolated and interacting systems of aqueous solutions, hydrogen-moderated latticed fuel, and undermoderated and little-moderated fuels. Tabular and graphical criticality data are included from calculations and measurements on various configurations, enrichments, and materials. The distinctive nuclear safety designs required by each of the operations encountered in fuel fabrication plants are discussed. The processes for fabrication of ceramic oxide pellets and extrusion of U-Al tubular elements are briefly described and analyzed. (H.D.R.)

10082 (ORNL-NSIC-21) TECHNOLOGY OF STEEL PRESSURE VESSELS FOR WATER-COOLED NUCLEAR REACTORS. A Review of Current Practice in Design, Analysis, Materials, Fabrication, Inspection, and Test. Whitman, G. D.; Robinson, G. C. Jr.; Savolainen, A. W. (eds.) (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 675p. Dep. CFSTI.

The current practices in the design and fabrication of steel pressure vessels for light-water-cooled nuclear reactors in present and immediate-future commercial use are reviewed. The specified service and predicted environmental conditions are identified, along with an evaluation of the effects of these parameters on materials behavior. Materials fabrication and materials properties of interest in pressure-vessel fabrication are reviewed, and the metallurgy of these materials is discussed. The basic aspects of fracture mechanics and crack growth are examined, with emphasis on the low-alloy steels of current interest. The codes and standards applied in the technology are discussed, and areas where augmentation and/or revision to these standards appears warranted are identified. The techniques for postoperational and in-service inspection are summarized and evaluated. (auth)

10083 (RISO-M-645) HETEROGENEOUS REACTOR THEORY: 2 GROUP, 3 DIMENSIONAL THEORY FOR REFLECTED LATTICES. Pedersen, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 23, 1967. 51p. Dep.

The theory for calculating the criticality condition of a 3-dimensional, reflected heterogeneous reactor lattice in $r-\theta-z$-geometry with the two group formalism is given. Three computer codes, HETPOL 3, SOUSI and SOUSI 3 D R are briefly described. (auth)

10084 (ORNL-tr-1505) DETERMINATION OF A BASE FOR THE PROPER FUNCTION AND OF THE CORRESPONDING NORM FOR THE BOLTZMANN INTEGRAL-DIFFERENTIAL EQUATION AT A GIVEN VELOCITY AND IN A SPHERICAL CONFIGURATION. Lafore, Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by Gregory L. Boisvert (Oak Ridge National Lab., Tenn.), from report CEA-R-2926. 51p. Dep. CFSTI. JCL $5.60 fs, $1.73 mf.

Bases for the proper orthogonal functions which are solutions to the spherical Boltzmann integrodifferential equations are established. Sample applications to the interior and exterior Milne problems and flux at the boundary of two media are presented. (M.L.S.)

10085 TRANSPORT ERROR BOUNDS VIA P_N APPROXIMATIONS. Davis, James A. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 31: 127-46(1968).

By using variational means, it is found for any one velocity system with non-zero absorption cross section having either vacuum, reflecting, or antireflecting boundary conditions that the transport solution is, in a very specific sense, approached monotonically from above by the solutions to the odd P_N equations and from below by the solutions to the even P_N equations, provided the P_N solutions are obtained by using appropriate continuity and external boundary conditions. That is to say, odd and even P_N calculations "bracket" the transport solution. In one instance, the escape probability is bounded and, in another, the disadvantage factor. This theoretical result, along with certain numerical evidence, suggests that the modified P_2 approximation of Dawson may serve as a practical, reasonably accurate alternative to diffusion theory for certain realistic design problems. 24 references. (auth)

10086 COMPARISON OF HETEROGENEOUS NUCLEAR-REACTOR LATTICE THEORY WITH EXPERIMENT. Graves, W. E.; Benton, F. D.; Satterfield, R. M. (E. I. Du Pont de Nemours and Co., Aiken, S. C.). Nucl. Sci. Eng., 31: 57-66 (1968).

Source-sink methods of calculation are compared with a set of experiments with mixed-fuel lattices in a heavy-water moderator. The theoretical model used was C. N. Klahr's modification of the Feinberg—Galanin theory. A comparison of calculation and experiment was made both for thermal-neutron density ratios within the lattice components, and for critical geometric bucklings. Agreement was good in the case of thermal-neutron density ratios and rather good for radial bucklings. The moderate disagreements between calculated and experimental critical vertical bucklings were ascribed primarily to errors in the cell codes used to generate input for the mixed lattice calculations. 26 references. (auth)

10087 MACHINE FOR CONTINUAL FUEL EXCHANGE IN NUCLEAR POWER REACTORS. Feretic, Danilo; Zake, Geza. Nukl. Energ., 3: No. 6, 22-5(1966). (In Serbo-Croatian).

A reactor loading machine for gas-cooled graphite-moderated Magnox type reactors and pressurized heavy water reactors is described. Fabrication of a prototype at the Djuro Djaković Institute is discussed. The possibility of Yugoslav industrial fabrication of these loading machines is considered. (TSS)

10088 ANALOG AND DIGITAL SOLUTION OF REACTOR DYNAMICS PROBLEMS. Speelman, J. E. Atoomenergie Haar Toepass, 9: 225-30(Oct. 1967). (In Dutch).

The solution of reactor dynamics problems by means of computers is considered. Calculations were made for the NERO program with both an analog and a digital computer. Results are discussed. (TSS)

10089 HYDROGEN EMBRITTLEMENT: A REACTOR SAFETY PROBLEM? Rossin, A. David. Power Reactor Technol. Reactor Fuel Process., 10: 102-10(Spring 1967).

The effects of hydrogen on reactor pressure vessels are outlined. Key factors in hydrogen-induced, delayed, brittle fracture of steels are discussed. Methods of testing for hydrogen embrittlement are outlined. Radiation effects on steels are discussed; these effects are considered in combination with hydrogen embrittlement. The safety of reactor pressure vessels is then examined. 23 references. (M.L.S.)

10090 PRESSURE SUPPRESSION DEVICE. Ebata, Takeo (to Hitachi Ltd.). Japanese Patent 1967-4878. Feb. 28, 1967. Filed Feb. 24, 1965.

By the method proposed, the steam from the dry well due to a reactor accident can be more directly contacted with water in the pressure suppression chamber which minimizes the pressure increase in the dry well. The suppression chamber consists of a dry well containing the reactor core; pressure suppression chambers partly filled with water; and the pipes connecting the dry well and the chambers. A helical guide-plate is installed in each pipe located in the water of the suppression chamber. (NSA of Japan)

10091 PERIOD METER FOR THE LINEAR-OUTPUT TYPE REACTOR. Kuwabara, Jun (to Japan Atomic Energy Res. Inst.). Japanese Patent 1967-4200. Feb. 21, 1967. Filed June 7, 1963.

An improved period meter is proposed in which, instead of the conventional, logarithmic-conversion differential system, the output change-rate is divided utilizing the linear output system. The reactor-period measurement is made possible by adding a few devices to the ordinary linear-output system without the use of a logarithmic period meter. The result is the simplification of the reactor neutron-measurement instrumentation. The linear-output system consists of a neutron-flux detector, a dc amplifier for amplifying the detector output, a pointer, a slide resistance engaged with the pointer, and an automatic balancing device with a motor for moving the pointer according to the dc amplifier output. It further includes another slide resistance engaged with the slide resistance, a device for obtaining the output change-rate of the linear output system, and an amplifying circuit whose amplification degree is continuously changed by means of the "another" slide resistance with the change-rate output as its input. The reciprocal reactor-period is measured by means of the output of this amplifying circuit. (NSA of Japan)

10092 DEVICE FOR PREVENTING LEAKS OF A COOLANT IN A NUCLEAR REACTOR. Ueda, Kazunari (to Mitsubishi Atomic Power Ind., Inc.). Japanese Patent 1966-16006. Sept. 9, 1966. Filed Apr. 30, 1963.

The device, simple in construction, provides reliable prevention of joint leaks due to thermal expansion. The device in the form of a ring of narrow width is located at the circumferential joint of two concentric pipe ends. This ring is cut on its surface with inclined radial grooves. Pieces of material engage with the radial grooves and slide down on the surface by gravitation to stop any gap formed between the body and the cylindrical body. (NSA of Japan)

10093 SAFETY DEVICE FOR A NUCLEAR REACTOR. Suzuki, Yasuyuki (to Fuji Electric Mfg. Co., Ltd.). Japanese Patent 1966-16918. Sept. 26, 1966. Filed Feb. 27, 1964.

In the reactor scram, a control rod is usually dropped into the reactor core by gravitation. In this case, to increase the dropping power in the liquid moderator an additional force is applied by means of a spring and cylinder. In the proposed device a weight is used to achieve much faster dropping. It consists of the reactor vessel containing the reactor core and liquid moderator; a control rod inserted vertically into the core; the control-rod drive which suspends the control rod; a weight which settles on the extension of the control rod; and a bumper which receives the weight when it drops with the control rod. In the reactor scram the weight drops with the control rod, and after dropping for a set vertical distance it is stopped and received by the bumper. The control rod, which has detached from the weight, drops into the reactor core for the final reactor shut-down. (NSA of Japan)

10094 ELECTRICAL DEVICE FOR ALIGNING FUEL CARTRIDGES IN A CHANNEL OF A NUCLEAR REACTOR. Liermann, J. (to Commissariat a l'Energie Atomique). Canadian Patent 760,531. June 6, 1967. Priority date Apr. 10, 1962, France.

The device transmits a potential difference from one nuclear fuel cartridge to the next when the two are in contact and approximately aligned. On the ends of each cartridge are studs of such geometric form that no accidental electrical contact can occur unless the two are of like polarity. In one cartridge in the stack, the contacts of one end are connected to the terminals of a thermoelectric probe. The important feature is a fixed central contact stud and a peripheral stud supported by the upper edge of a resilient annular cup. The cup is fixed to the peripheral stud concentrically with the central stud so that in the absence of stress, the peripheral stud projects beyond the apparent contour of the remainder of the cartridge. (F.S.A.)

10095 DRIVE MECHANISM FOR A REACTOR CONTROL ROD. Akimoto, Seiichi; Sato, Yusuke (to Hitachi Ltd.). Japanese Patent 1967-5960. Mar. 30, 1967. Filed Dec. 15, 1964.

The control-rod drive mechanism proposed is used in a pressure vessel; the rapid drive is possible, the time lag at the reactor scram is very short, and the control rod can be set at any given position. In the outer cylinder is installed a (control-rod) drive rod with a screw cut onto one end and the other end having a cylinder. Within this "latter" cylinder are: a link mechanism, which prevents the dropping of the drive rod and which enables the up and down movement of a control rod by opening or closing itself; and a lever, hooked onto the cylinder, which maintains the opening or closing of the link mechanism and sustains the weight of the control rod. The armature and spring for handling the lever are within the outer cylinder and the electromagnetic coils for operating the armature are on the outside of the outer cylinder. A reactance motor is installed at the screwed end of the drive rod, the screw engaging with the rotor of the motor; the drive rod is moved up or down by the rotation of the motor. A gear is attached to a part of the rotor, and the gear connects to a sealed synchro-oscillator, which is in the outer cylinder. An electromagnet is installed, just outside the outer cylinder, at about the position of the lever so as to move together with the drive rod by means of a signal from the synchro-oscillator. (NSA of Japan)

10096 MECHANISM FOR DECELERATING THE DROPPING OF A REACTOR CONTROL ROD. Amamiya, Shigeru (to Hitachi Ltd.). Japanese Patent 1966-22160. Nov. 2, 1966. Filed Dec. 12, 1964.

Using the proposed mechanism, the shock and recoil of a reactor control rod in a reactor scram can be eliminated by decelerating the motion of dropping near the end of scram action. The dropping into the reactor core is achieved by means of an electromagnet. Beyond the electromagnet in the overall system, the connection is the armature (attracted to the magnet), a short cylindrical body, a rod, and the control rod. The upper part of this connection is contained in an outer cylinder, in a way similar to that of the usual piston-and-cylinder. The armature and the short cylindrical body are rotatable within the outer cylinder, by means of rollers between the outer cylindrical body and the armature. Grooves are cut on the inside of the wall of the outer cylindrical body, for the rollers to run through during the dropping. Near the end of scram motion, the vertical dropping of a control rod is converted into the rotation of the armature and short cylindrical body to decelerate the dropping motion. (NSA of Japan)

10097 SUPPORT FOR A REACTOR PRESSURE VESSEL. Hamada, Kunio (to Hitachi Ltd.). Japanese Patent 1966-24222. Dec. 9, 1966. Filed Aug. 8, 1963.

The advantages to the proposed method are superior absorption of heat in the vessel wall, and of its expansion due to the internal pressure, and sufficient strength against the horizontal load at the time of an earthquake. A number of rectangular plates are arranged vertically around the circumference of a spherical, reactor pressure-vessel, at regular intervals, with their bottom end in contact with the circumferential surface of the vessel. The upper edge of each plate is bent outward. This part is fixed onto the surrounding foundation. The lower edge is fixed to the blanket, which is embodied with the pressure vessel at nearly the middle circumference of the vessel. (NSA of Japan)

10098 PRESTRESSED CONCRETE PRESSURE VESSELS FOR USE IN NUCLEAR INSTALLATIONS. Sage, Frederick (to United Kingdom Atomic Energy Authority). U. S. Patent 3,355,357. June 3, 1965. Priority date June 17, 1964, Great Britain.

A nuclear reactor installation comprising a cylindrical concrete pressure vessel having cylindrical side walls adapted to withstand internal pressure forces of the fluid within the chamber and having opposing ends is described. The enclosed reactor core and heat exchangers are braced to the opposing ends of the pressure vessel by cable. The cable allows external coolant to pass inside the pressure vessel by means of a pressure tube. (U.S. Pat. Gazette)

10099 NUCLEAR REACTOR CORE ORGANIZATION AND FUEL ASSEMBLY THEREFOR. Rohlin, John F. (to Combustion Engineering Inc.). U. S. Patent 3,351,533. Dec. 3, 1964.

The description of a reactor core is presented which consists of a plurality of elongated fuel assemblies in parallel side-by-side arrangement. Each fuel assembly is comprised of elongated parallel fuel rods retained in evenly spaced relation and arranged in a first group of parallel rows and a second group of parallel rows oriented at right angles to the first group. The core includes groups of four of the assemblies formed into subassemblies and oriented so that a cruciform passageway is formed centrally. The oppositely extending arms of the cruciform configuration are coplanar. (U.S. Pat. Gazette)

10100 DEVICE FOR PRODUCING A NUCLEAR-REACTOR REACTIVITY. Wajima, Tsunetaka; Yamada, Shuji (to Hitachi Ltd.). Japanese Patent 1967-4639. Feb. 25, 1967. Filed Oct. 13, 1964.

By the method proposed, the step-wise (or pulsed) reactivity can be given with an extremely short rise-time; and furthermore the time can be accurately determined. It consists of the 1st and the 2nd region both enclosed in a neutron absorber within the reactor core (including the reflector); the open region formed between the outer two regions; and a body of a neutron absorbing or multiplying material which moves through the 1st region, the open region and the 2nd region (and vice versa). The step-wise (or pulsed) change, negative or positive, of the reactivity can be obtained when the moving body passes through the open region. (NSA of Japan)

10101 PRESSURE SUPPRESSION METHOD, EMPLOYING A STEAM SPACE. Yamanouchi, Hajime; Hayashi, Tsutomu (to Hitachi Ltd.). Japanese Patent 1967-4640. Feb. 25, 1967. Filed Sept. 29, 1964.

By the method proposed, the "maximum" pressure both in the dry well and the pressure suppression chamber can be minimized at the time of a reactor accident by removing air in the dry well. The steam from the primary coolant system due to a reactor accident is condensed in the pressure suppression chamber. The dry well is always (before the accident) filled with a gas such as steam, which condenses in the liquid in the suppression chamber. (NSA of Japan)

10102 REACTOR CONTAINMENT VESSEL. Sakakibara, Michio (to Hitachi Ltd.). Japanese Patent 1967-5958. Mar. 10, 1967. Filed Feb. 6, 1965.

In the reactor containment vessel proposed, the pressure increase at the time of a reactor accident can be suppressed very effectively by using a double containment. It includes a pressure suppression chamber, partly filled with water, located outside the reactor containment vessel; the outer containment vessel; the inner, flexible containment vessel in which the reactor pressure vessel is contained; and a pipe, which connects directly the suppression chamber and the inner vessel. (NSA of Japan)

10103 POWER-CONTROL ELEMENT FOR A NUCLEAR REACTOR. Sugaya, Junichi (to Hitachi Ltd.). Japanese Patent 1966-19198. Sept. 7, 1966. Filed Jan. 21, 1964.

The power-control element proposed consists of the outer enclosing tube; a neutron absorber in the form of a square tube; the nuclear fuel just below the absorber; and the support in the form of a square tube below the fuel. Rollers are provided in cuts made through the wall of the square tubes for the tubes to smoothly move along the inside surface of the enclosing outer tube. The roller is pressed against the inside surface by means of its arm and the plate spring (attached to the other end of the arm), all inside the square tubes. The pressure applied to the roller through the spring can be adjusted by means of a bolt screwed in the wall of the square tube, which gives tension to the spring or releases it. The resulting advantages are, in addition to adjustability of the pressure, ease of construction, smooth flow of a coolant through the enclosing tube, and elimination of damage to the enclosing tube. (NSA of Japan)

10104 BURN-UP MEASURING DEVICE. Yamanouchi, Hajime (to Hitachi Ltd.). Japanese Patent 1966-19199. Sept. 7, 1966. Filed Feb. 10, 1964.

The fuel burn-up in a nuclear reactor is usually measured by means of an activated Co wire, numerical calculations, or direct measurement of the fuel itself. By the method proposed, this measurement can be done easily and non-destructively merely by attaching a measuring device to the fuel rod. The device proposed consists of the so-called container; the lid through which the electrical terminals penetrate; a plurality of empty spaces made inside the container by several partitions; and a material, filled in other spaces than the empty spaces, which evolves a gas by neutron absorption. (NSA of Japan)

10105 FUEL ELEMENTS FOR NUCLEAR REACTORS. Engel, Wilhelm; Cautius, Werner; Schoen, Kurt. U. S. Patent 3,346,462. Mar. 19, 1965. Priority date Mar. 25, 1964, Germany.

The fuel element comprises a graphite sphere with an annular chamber near the external surface formed about a central axis of the sphere and filled with potted fissile material. The graphite sphere is in the form of two hemispheres held together by a screw-threaded connection, with the chamber formed by an annular recess in each hemisphere. An annular graphite closure plug is positioned within the chamber at the boundary between the two hemispheres to act as a screen between the fissile material in the two parts of the chamber and the boundary. (TSS) (U. S. Pat. Gazette)

10106 DEVICE FOR ADJUSTING THE RELATIVE DECAYS OF RADIONUCLIDES. Yamanouchi, Hajime (to Hitachi Ltd.). Japanese Patent 1966-19200. Sept. 7, 1966. Filed Mar. 10, 1964.

When monitoring reactor coolant-water, or detecting a failed fuel, the coolant water is measured for radioactivities. However, the activities are changed with the lapse of time after leaving the reactor core. In order to measure a particular nuclide, the proper time after leaving the core must be chosen. The device proposed is used for this purpose, i.e., for delaying the flow of coolant water. It is essentially a part of the piping in the system which prevents the flow of coolant. It consists of a section of the piping, its entrance and exit, a series of flow-preventing plates attached onto one side of the part, and another series of flow-preventing plates installed within the part which are movable so as to engage between the said outer plates. By moving the series of plates back and forth appropriately, the flow of coolant through the section can be changed for the purpose of adjusting the relative decays of radionuclides. (NSA of Japan)

10107 MODERATOR CORES FOR NUCLEAR REACTORS. Warner, Philip Cloudesley (to United Power Co. Ltd.). U. S. Patent 3,351,535. Nov. 8, 1965. Priority date Nov. 13, 1964, Great Britain.

A reactor moderator core assembly is described which consists of a plurality of closely spaced adjacent columns of vertically aligned prismatic blocks with adjacent blocks forming juxtaposed parallel prism faces and keyways in the faces. Solid keys are spaced longitudinally along the keyways. (U. S. Pat. Gazette)

10108 HYDROGEN DIFFUSION REACTOR CONTROL. Magladry, Robert (to Martin-Marietta Corp.). U. S. Patent 3,351,534. June 12, 1964.

A hydrogen flow system for reactor control is described. The reactor control system consists of an external hydrogen source with reversible flow control and a hydride material located in the core zone. (U. S. Pat. Gazette)

10109 NUCLEAR REACTOR FUEL ELEMENTS. Weaver, John Harold (to United Kingdom Atomic Energy Authority). U. S. Patent 3,345,733. Oct. 23, 1964. Priority date Nov. 7, 1963, Great Britain.

A method is described for fabricating a fuel element of the type comprising a number of part annular plates bearing fissile material and supported at their longitudinal edges by radial support members so as to form a series of spaced coaxial tubes. The longitudinal edges of the fuel plates are loosely supported in grooves in the radial support members, mounted on a mandrel, and passed between radially disposed deforming members. Radial inward pressure is exerted on the edges of the support members to deform the material so that the groove walls grip the edges of the fuel plates. (TSS) (U. S. Pat. Gazette)

10110 BURST CAN DETECTION SYSTEM. (to Commissariat a l'Energie Atomique). French Patent 1,403,811. May 17, 1965. Filed May 13, 1964.

The fuel channels in a nuclear reactor can be connected by means of a valve system with a scanning circuit comprising a detector unit, or with a burst follower circuit also comprising a detector unit. Each detector unit is formed by the association of a delayed-neutron detector and an electrostatic collection detector of solid fission products (rubidium and cesium ions). Each delayed neutron detector comprises a filter for holding back iodine and bromine from gas samples and a device for measuring the neutron emission of the filter. (IIB)

10111 SAFETY AND CONTROL DEVICE FOR A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,400,510. Apr. 20, 1965. Filed Apr. 15, 1964.

A control element is positioned in a vertical channel of a reactor and comprises several rows of trapezoidal plates of neutron absorbent material. Each plate is hinged by its major base to the major base of the adjacent plate and by its minor base to the minor base of the other adjacent plate to form a row of hinged elements. The end plates of each row are fixed, one to the inlet of the channel and the other to a weight connected to a control cable for moving rows into and out of the reactor core. (IIB)

10112 NUCLEAR REACTOR LOADING MACHINE. Lemesle, G.; Martin, R.; Monteil, M.; Roche, R.; Rouge, P. (to Commissariat a l'Energie Atomique). Canadian Patent 767,764. Sept. 19, 1967. Priority date Feb. 20, 1962, France.

A gas cooled reactor with a vertical core has the fuelling machine located within the shield in a chamber above the calandria. Decontaminated gas enters this chamber which is kept at a slightly higher pressure than in the outlet ports and in the gas space about the calandria. The machine runs on a radially extending monorail and by the use of rollers can take a position over any tube which leads to a fuel channel. A prehensile device withdraws or inserts fuel cartridges and provision is made to store spent fuel in the machine for ultimate disposal to a deactivation pool. (F.S.A.)

10113 NUCLEAR REACTOR REFUELLING SYSTEM. Lemesle, G.; Martin, R.; Monteil, M.; Roche, R.; Rouge, P. Canadian Patent 767,765. Sept. 19, 1967. Priority date Feb. 20, 1962, France.

The arrangement is similar to that in Canadian Patent 767,764 with the addition of a periscope tube through the biological shield to monitor the fuelling operation. Television cameras may be added to improve control. (F.S.A.)

10114 NUCLEAR REACTOR REFUELLING FACILITY. Lemesle, G.; Martin, R.; Rouge, P.; Vivien, J. (to Commissariat a l'Energie Atomique). Canadian Patent 767,766. Sept. 19, 1967. Priority date Dec. 11, 1962, France.

As an adjunt to Canadian Patents 767,764 and 767,765 this device describes a system for rapid transfer of fuel cartridges between a magazine inside the servicing chamber to one outside the chamber. From the latter, the fuel is conveyed to the deactivation pool. (F.S.A.)

GENERAL

10115 (AERE-R-5492) APPROXIMATE EQUATIONS FOR THE DIFFUSION AND FLOW OF GASES IN POROUS MEDIA. Hewitt, G. F. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1967. 25p. Dep. CFSTI. UK 4s. 0d.

Approximate equations are developed for the flow of gases under an overall pressure gradient in a straight capillary, and the application of these equations to porous media is discussed. Preliminary results show encouraging agreement with the predicted values. (auth)

10116 (AERE-R-5571) AN ELEMENTARY ACCOUNT OF THE THEORY OF IMAGE CONTRAST IN ELECTRON MICROSCOPES. Makin, M. J. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1967. 49p. Dep. CFSTI. UK 7s. 0d.

An elementary account is given of both the kinematical and dynamical theories of diffraction contrast, including the treatment of multiple beams. The mathematical derivations are given in considerable detail, so that readers with little mathematical knowledge can follow and understand how the final expressions are obtained. An appendix gives all the mathematics required (including the use of matrices). (auth)

10117 (AERE-R-5598) THE DATA LINK CONTROLLER FOR THE FAST (880k bit/sec) A.E.R.E. DATA LINKS. Austin, J. S. (Atomic Energy Research Establishment, Harwell, Eng.). Oct. 1967. 15p. Dep. CFSTI. UK 3s. 0d.

A description is given of the details of the Controller of the Fast (880k bit/sec) Data Transmission Links between computers at A. E. R. E. The main functions of the equipment are parallel/serial and serial/parallel conversion, buffering between computer and transmission system, and interfacing with the computers being used. (auth)

10118 (BNL-50051) ENERGY CONVERSION IN PHOTOSYNTHESIS. Brookhaven Lecture Series Number 62. Olson, John M. (Brookhaven National Lab., Upton, N. Y.). Jan. 11, 1967. 9p. Dep. CFSTI.

All photosynthetic organisms use chlorophylls and cytochromes for the primary energy conversion steps. Green plants utilize two photochemical steps in series to obtain hydrogen from water, whereas bacteria use only one photochemical step to obtain hydrogen from such donors as H_2S and ethanol. Therefore, green plants can produce oxygen and photosynthetic bacteria cannot. Eight quanta of 1.8 eV are sufficient to produce one oxygen molecule and simultaneously to fix one CO_2 molecule under ideal conditions of 100% quantum conversion. Energy conversion efficiency is about 40%. Chlorophyll traps the light energy and funnels it to photochemical reaction centers for conversion to chemical energy. The energy conversion reactions of photosynthesis from light absorption to the production of ATP and powerful reductants are carried out in specialized cellular organelles. In green plants these are the chloroplasts which carry out oxygen evolution and carbohydrate synthesis as well. (auth)

10119 (BNL-50074) TALKING TO COMPUTERS. Brookhaven Lecture Series Number 44. Denes, John E. (Brookhaven National Lab., Upton, N. Y.). Feb. 24, 1965. 10p. Dep. CFSTI.

A brief nontechnical discussion of digital computers and machine language is presented. (W.H.K.)

10120 (BNWL-SA-1541) MEASUREMENTS OF TURBULENCE IN THE LOWER ATMOSPHERE. Elderkin, Charles E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 4, 1967. Contract AT(45-1)-1830. 21p. (CONF-671205-3). Dep. CFSTI.

From Symposium on Theory and Measurement of Atmospheric Turbulence and Diffusion in the Planetary Boundary Layer, Albuquerque, N. Mex.

Measurements of turbulence in the three components of the wind were made at several heights up to 87 meters, in neutral, unstable, and stable conditions, and in a variety of wind speeds. The data were analyzed on an analog computer for power spectral density distributions, cospectral density distributions and Reynolds' stresses. Similarity of the power spectral distributions was observed most noticeably for the vertical component, reasonably well in the longitudinal component, and least clearly for the lateral component. The spectra for the vertical component measured at 12 meters and above, where bouyancy becomes effective, demonstrated definite convective energy peaks in unstable conditions. These occurred in addition to the mechanical energy peaks which corresponded in the normalized spectral distributions to those for the tests close to the ground where mechanical energy dominated the structure. At 12 meters in stable conditions, the entire spectrum was shifted significantly to higher wave numbers, for all three components, while at lower levels only a slight shift to higher wave numbers was detected for stable cases. (auth)

10121 (CISE-106) COMPILER FOR OPERATOR PRECEDENCE LANGUAGES. De Lotto, I.; Ghirardi, A.; Morpurgo, R. (Centro Informazioni Studi Esperienze, Milan (Italy)). Jan. 1967. 31p. (CONF-661130-1).

From Proceedings of Automation and Instrumentation Congress, Milan, Italy.

A compiler is described which translates programs written in a language belonging to the family of precedence operator languages. This compiler is the first step toward a general purpose translator, whose object is the optimization of output code. The two functions of the translator, analysis and generation, are carried out in two consecutive stages. The compiler is written in ALGOL. (W.H.K.)

10122 (COO-256-77) PRECISE POLAROGRAPHY IN NONAQUEOUS SOLVENTS. Schaap, Ward B. (Indiana Univ., Bloomington. Dept. of Chemistry). Dec. 1, 1967. Contract AT(11-1)-256. 2p. Dep. CFSTI.

A comparison was made of experimental and theoretical polarographic half-wave potentials over a wide range of supporing electrolyte concentration. The particular system studied was thallous nitrate in the presence of sodium nitrate as supporting electrolyte. Both ethylenediamine and glacial acetic acid were used as solvents. (M.C.G.)

10123 (COO-1148-112) POLAROGRAPHIC BEHAVIOR OF ORGANIC COMPOUNDS. Final Report, September 1, 1952-August 31, 1967. (Michigan Univ., Ann Arbor. Dept. of Chemistry). Contract AT(11-1)-1148. 19p. Dep. CFSTI.

Investigations, using polarographically related techniques, of the nature, interpretation, and utilization of organic electrode processes in aqueous and nonaqueous media are reviewed. Topics studied include: alternating-current polarography, current-time relations at the dropping-mercury electrode, current-potential relations at rotating-disk electrodes, inorganic electrode processes, adsorption and the electrical double layer, voltammetry with solid electrodes, electrochemistry in nonaqueous media, and correlation of polarographic behavior with structure and chemical reactivity. (111 references). (M.C.G.)

10124 (COO-1675-4) KNUDSEN AND MOLECULAR DIFFUSION OF GASES IN CAPILLARIES AND POROUS SOLIDS OVER LARGE PRESSURE RANGES. Technical Progress Report, April 1, 1967-March 31, 1968. Geankoplis, Christie J. (Ohio State Univ. Research Foundation, Columbus). Nov. 22, 1967. Contract AT(11-1)-1675. 16p. Dep. CFSTI.

The diffusion of gases in small, straight capillaries or in porous media in the range of very low to high pressures is important in diffusion in porous catalysts, separation of gases in porous barriers, and diffusion in capillaries or other types of equipment. Few theories and models are available for predicting this diffusion at constant total pressure in these cases. The effects of many variables, as pressure, pore geometry, and the number of individual gases present, are still uncertain. Previous experimental data in the literature covered only a 50/1 range of pressures in porous solids, which did not cover the entire three-mechanism range of Knudsen, transition, and molecular diffusion. Most of the diffusion in industrial catalysts at one atmosphere pressure is in the transition region. Experimental data were obtained for diffusion of binary gases in different synthetic porous structures. One solid contained one micropore size and many macropore sizes, while another contained one macropore and two micropores. Theoretical equations were derived for these cases using a modified random pore model and the experimental data checked the predicted data. The data covered a 1300/1 pressure range which included the Knudsen and most of the transition region. A high pressure apparatus has been designed and is being constructed to extend the range of pressures to 345,000/1 which will allow all three regions to be studied. A method has been devised to make a plug containing 100 straight capillaries in parallel. Preliminary experiments are being carried out to test the theoretical capillary equation. A solution to the differential equations for diffusion of a three-component gas mixture was obtained for the complete transition region in an open system. The equations indicate that a maximum or minimum can occur in the concentration plot and that under certain conditions a diffusion barrier can exist. (auth)

10125 (DP-1113) COMPUTER PROGRAMS FOR ORDERING, LISTING, AND CIRCULATING LIBRARY BOOKS. Buhl, Norma A.; Feldman, Myra S. (Du Pont de Nemours (E. I.) and Co., Savannah River Lab.). Sept. 1967. Contract AT(07-2)-1. 50p. Dep. CFSTI.

The Technical Library of the Savannah River Laboratory uses COBOL programs to assist in purchasing and circulating books and to provide book lists and printed catalogs. The programs are written for the IBM System/360-65 with 524K storage and may be applied to a library of any size. Bibliographic and cataloging data for the library holdings are stored on magnetic tape from which data can be recalled in a number of print formats. (auth)

10126 (GEPP-2) THE GLASS MICROBALLOON (GMB) RESIN HYDROSPENSER. Creed, K. E. Jr. (General Electric Co., St. Petersburg, Fla. [Pinellas Peninsula Plant]). July 9, 1963. Contract AT(29-2)-656. 75p. (R-63XF8). Dep. CFSTI.

It is feasible to utilize the Hydrospenser for metering, mixing, and dispensing the GMB-resin-DEA system within specification requirements. Subassemblies and final units cast were equivalent or better (from a casting aspect) than hand-poured units, and exotherm characteristics of the Hydrospenser pours were well below the critical temperature region. A minimum of further evaluation would be required to prove the exact capabilities of the equipment. Two immediate benefits were derived: utilization of an improved GMB-resin premixer and storage facility, and achievement of ±1% tolerance control on the mix composition by assay technique. (auth)

10127 (GEPP-3) DESIGN OF A LOCKFOAM HYDROSPENSER. Gillespie, T. J. (General Electric Co., St. Petersburg, Fla. [Pinellas Peninsula Plant]). May 21, 1965. Contract AT(29-2)-656. 54p. (R-65XF2). Dep. CFSTI.

The design and modification of a Hydrospenser for metering, mixing, and dispensing urethane foam systems are discussed. The GEXF Laboratory Hydrospenser for metering, mixing, and dispensing urethane foam systems has demonstrated excellent capabilities in the shot size range of 30 to 120 grams for the large volume system, and 5 to 20 grams for the small volume system. The respective accuracies are from ±0.17% (at 120 grams) to ±0.41% (at 30 grams) for large volume systems and from ±0.12% (at 20 grams) to ±0.38% (at 5 grams) for small volume systems. (auth)

10128 (GEPP-4) ALUMINUM OXIDE/EPOXY HYDROSPENSER. Gillespie, T. J. (General Electric Co., St. Petersburg, Fla. [Pinellas Peninsula Plant]). Dec. 19, 1966. Contract AT(29-2)-656. 58p. (R-66XF7). Dep. CFSTI.

The design of a Hydrospenser for metering, mixing, and dispensing an aluminum oxide-Epon 828 epoxy resin-Curing Agent "Z" system and the results of machine operation are discussed. It is feasible to use the Hydrospenser for automatic metering, mixing, and dispensing of the aluminum oxide-Epon 828 resin-Curing Agent "Z" system within the specification requirements. (auth)

10129 (GEPP-14) APPLICATION OF ESTIMATING PRECISION OF MEASURING INSTRUMENTS AND PRODUCT VARIABILITY. Szedziewski, L. F. (General Electric Co., St. Petersburg, Fla. [Pinellas Peninsula Plant]). Nov. 22, 1967. Contract AT(29-2)-656. 10p. (R-67-ND-11). Dep. CFSTI.

A method is described for determining the relative precision of measuring instruments and product variability. This information can be especially helpful to engineers with little or no statistical background. All that is needed to use this method is a desk calculator and knowledge of Chi-squared distribution. Calculations required to solve a typical example of the precision method are included. (auth)

10130 (IS-1656) DIAN II: AN ALL FORTRAN SYSTEM FOR PROGRAMMING A DIGITAL COMPUTER IN TERMS OF ANALOG COMPONENTS. Torrey, H. L.; Farris, G. J.; Burkhart, L. E. (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 42p. Dep. CFSTI.

DIAN-II is a completely revised version of an earlier DIAN programming system by which a digital computer may be programmed in a manner very similar to the technique of writing a flowsheet for an analog computer. In using DIAN-II, the programmer need be concerned only with the relations between inputs and outputs of basic computational components which perform specific mathematical operations. DIAN-II is written entirely in FORTRAN for IBM System 360 machines but can be very easily modified to run on any machine with a FORTRAN compiler. The basic system consists of seven types of components—integrators, summers, constant multipliers, function multipliers, dividers, sine generators, and empirical function generators. (auth)

10131 (IS-1693) COMPUTER PROGRAM FOR INTERPRETATION OF SPARK SOURCE MASS SPECTROGRAPH PHOTOPLATES. Conzemius, R. J.; Erbeck, D. H.; Elbert, S. T. (Ames Lab., Iowa). Oct. 1967. Contract W-7405-eng-82. 74p. Dep. CFSTI.

A method is described that takes raw data from a spark-source mass spectrograph photoplate and utilizes computer techniques for both interpretation and computation of elemental impurity levels. A general description of the program is provided as well as a block diagram and complete listing. An example shows the type of input and output data. Limitations of the method are discussed briefly. (auth)

10132 (MLM-1403) ISOTHERMAL TWIN-BATH CALORIMETER 87. Jordan, K. C.; Blanke, B. C.; Birden, J. H.; Dudley, W. A. (Mound Lab., Miamisburg, Ohio). July 31, 1962. Contract AT(33-1)-Gen-53. 24p. Dep. CFSTI.

Calorimeter 87, a new double-bath type precision calorimeter, was developed to measure the heat output of objects of odd geometry. It is capable of measuring heat outputs of samples in the range of 1.0 to 125 watts which do not exceed 16 in. in length and can be inserted into an 8-in. square hole. The construction, theory, application, and errors of this calorimeter are described. (auth)

10133 (NAA-SR-Memo-12372) GENERALIZED DATA REDUCTION PACKAGE. PART I. ROUTINES FOR TEST, SELECTION, AND WEIGHTING OF DATA. Beller, L. S. (Atomics International, Canoga Park, Calif.). Mar. 20, 1967. 48p. Dep. CFSTI.

Three computer subroutines for statistical test and selection of experimental data and one subroutine for computing statistically weighted quantities are discussed. The three selection routines use varying criteria, depending on the desired form of analysis and on the available information about statistically expected behavior. Descriptions are given of computations and methods, and of considerations, limitations, and instructions for use. A listing of each code is provided. This memo is part of a series describing a system of modular subroutines of wide applicability for analysis, manipulation, and fitting of experimental data. (auth)

10134 (NP-17070) JAHRESBERICHT, 1966. (Annual Report, 1966). (Kernforschungsanlage, Juelich (West Germany)). 212p. (In German). Dep.

The general development and organization of the Julich Nuclear Research Installation and the work of the Installation for the THTR Association are outlined. Data are presented from the Scientific Institutes of the Installation on the analysis of genetic, physiological, and biochemical bases of radioresistance, direct radiation effects on cells, organs, and complete organisms, prevention or inhibition of radiation injuries by treatment of plants and animals after irradiation, reversible damage in irradiated tissue cultures, analysis of radiation effects in irradiated chicken embryos, cytological basic research with respect to delayed radiation damage, agricultural chemistry, soil science, anatomy and physiology of house animals, development of an activation analytical method for the determination of resorbed elements with enriched stable isotopes, investigation of element concentration in carcinomas, measurement of the trace element concentration in the blood and other samples as a function of the state of health, results of x-ray, γ, and electron irradiation of tumors, development of the gamma retina, enrichment of stable isotopes by thermodiffusion, transport properties of molten salts, radiolysis of CO, photolysis of H_2O, physical chemistry of the actinides, radiometric analytical methods, reactions of recoil tritium atoms with aliphatic amines, reactions of hot sulfur atoms with ethane, reactions of ^{38}Cl recoil atoms with simple aromatic compounds, chemistry of Tc and Pa, design of experiments with Bonn 500-MeV electron synchrotron, design of the 2.5-GeV electron synchrotron, small-angle scattering of neutrons with neutrons, neutron spectroscopic and theoretical studies of the dynamics of solids and liquids, determination of the spin-scattering cross section of metals, energy-dependent Milne problem in water, properties of the gas-filled mass separator SV II, compatibility studies of cesium with graphite, thermionic measurement cells, studies on a cross-circulated tube element bundle, control rods for gas-cooled reactors, hollow elements for gas-cooled reactors, loop studies, reactor construction materials, fast fission effects in beryllium oxide, diffusion of Li in BeO, theoretical studies of resonance absorption in pebble-bed reactors, theoretical studies of molten-salt reactor, development of heavy-water moderated thorium breeder, production, heating, and containment of plasmas at very high temperatures, studies on collision waves, plasma acceleration, operation of FRJ-1 and FRJ-2 reactors, design of the CO_2 loop LV 21 for the study of the mass transport of graphite, design of fuel element loop, and design and putting into operation of the BZ I, BZ II, and BZ III hot cells. The cooperation given by the applied mathematics, electronics, chemical analyses, and radiation protection sections is described. The publications and internal reports appearing in 1966 are compiled. (J.S.R.)

10135 (NP-17190) REPORT ON THE WORK OF THE INSTITUTE OF NUCLEAR SCIENCES. Progress Report No. 9, January–June 1967. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). 62p. (INS-238). Dep.

A summary of the work done at the Institute of Nuclear Sciences from January through June 1967 is presented. Discussed are projects in nuclear physics, radiation research, isotope geochemistry–stable isotopes, radioactive dating and radioactive fall-out, isotope applications, and instrumentation. (W.H.K.)

10136 (NVO-38-12) AIR-ASSIST, REVERSE-CIRCULATION SYSTEMS. Gilliland, O. C. (Fenix and Scisson, Inc., Tulsa, Okla.). Petroleum Consultants, Houston, Tex.). Mar. 1967. Contract AT(26-1)-38. 35p. Dep. CFSTI.

With the proposal to use air-assisted reverse liquid circulation for drilling deep large diameter holes, it becomes necessary to determine the air volumes required to give satisfactory drilling performance and thereby establish compressor requirements. An air-volume formula is developed, based on Bernoulli's equation. Work sheets are provided to facilitate field calculations of air-to-liquid ratios needed to achieve liquid circulating volumes from 1500 to 5000 gpm, in holes to 6000 feet deep, and at penetration rates as high as 10 feet per hour. Injection air-line size and length needed to satisfy maximum probable system demand are determined, as well as the corresponding maximum input air volume. A knowledge of air-to-liquid volume ratios allows the field engineer to vary air-line submergence for desired performance, using the included table which gives required air volumes and pressures under certain conditions expected to be encountered, or using the derived equation. (auth)

10137 (NYO-1480-82) THE NUMERICAL SOLUTION OF THE NAVIER-STOKES EQUATIONS FOR AN INCOMPRESSIBLE FLUID. Chorin, Alexandre Joel (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). Nov. 1967. Contract AT(30-1)-1480. 45p. Dep. CFSTI.

A finite difference method for solving the time-dependent Navier–Stokes equations for an incompressible fluid is introduced. This method uses the primitive variables, i.e., the velocities and the pressure, and is equally applicable to problems in two and three space dimensions. Test problems are solved, and an application to a three dimensional convection problem is presented. (auth)

10138 (ORNL-TM-2063(Pt.A)) CONFERENCE PROCEEDINGS IN THE DOCUMENT COLLECTION SECTION, CENTRAL RESEARCH LIBRARY. Howard, Elizabeth B. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 158p. Dep. CFSTI.

Information on unclassified conference proceedings in the Document Collection Section of the Central Research Library is made available by a Keywork-in-Context (KWIC) Index. Conference location and date(s) have been appended to the titles in order to provide additional key words. A Bibliographical Section and a Report Number Section, cross referencing the different numbers assigned the same report, are also supplied. The period covered is January 1960 through June 1967. (auth)

10139 (ORO-3518-4) ELECTROCHEMICAL STUDIES IN MOLTEN FLUORIDES AND OTHER HALIDES. Progress Report, April 1, 1967–March 31, 1968. Mamantov, Gleb (Tennessee Univ., Knoxville. Dept. of Chemistry). Jan. 4, 1968. Contract AT(40-1)-3518. 8p. Dep. CFSTI.

Additional EMF and exchange current measurements on the Ni/Ni(II) couple in molten LiF–NaF–KF (46.5–11.5–42 mole %) and $LiF-BeF_2-ZrF_4$ (65.6–29.4–5.0 mole %) were performed to verify its usefulness as a reference electrode in molten fluorides. The Ni/Ni(II) reference electrode was used to obtain the standard potentials for the couples Fe/Fe(II), Cr/Cr(II), and Be/Be(II) in $LiF-BeF_2-ZrF_4$ at 500°C. Voltammetric studies in molten LiF–NaF–KF were resumed after completion and checkout of the new controlled–potential controlled–current cyclic voltammeter and the modification of the dry box. Studies in molten $NaNO_3-KNO_3$ were completed. (auth)

10140 (RFP-926) FAILURE PREDICTION BY LUBRICANT ANALYSIS. Miller, N. H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Dec. 18, 1967. Contract AT(29-1)-1106. 4p. (CONF-670441-1). Dep. CFSTI.

From 10th ASME Plant Engineering and Maintenance Conference, Detroit, Mich.

The proper selection, analysis, and replacement of lubricants and hydraulic fluids are integral parts of the maintenance demanded by modern automated and ultra-high-precision machines. Analysis of lubricants in use with spectrographic and infrared methods can indicate equipment deficiencies and forecast possible failures. Testing and care of hydraulic fluids before use will help avoid trouble later. Performance tests of hydraulic fluids and other lubricants will produce useful, money-saving data. Daily preventive-maintenance schedules that include programmed equipment lubrication reduce down time and increase on-stream efficiency. (auth)

10141 (RISO-M-623) PALIDELIGHED AF INSTRUMENTERINGSSYSTEMER. NOTER TIL KURSUS I INDUSTRIEL ELEKTRONIK. (Reliability of Instrumentation Systems. Course Notes on Industrial Electronics). Timmermann, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sept. 1967. 32p. (In Danish). (R-14-67). Dep.

The basic reliability definitions and mathematical theory are presented and discussed in relation to electronic instrumentations for industrial processes. Some special reliability measures are introduced in order to evaluate safety and operational continuity properties which are of particular interest when continuous industrial processes are operated. The material is prepared for a 3 hour introductory course at the Technical University in Lyngby. (auth)

10142 (RLO-1922-7) THE ELECTRONIC PROPERTIES OF LIQUID SEMICONDUCTORS. Progress Report. Cutler, Melvin (Oregon State Univ., Corvallis. Dept. of Physics). Dec. 8, 1967. Contract AT(45-1)-1922. 11p. Dep. CFSTI.

The two main experimental activities reported on are Hall measurements and thermoelectric studies of Tl–Te. A study of the Tl–Te solutions was initiated in the 70 to 100 at.% thallium range, at temperatures above the miscibility gap (600 to 900°C). Some further work was done on making amorphous samples of Tl–Te. An important advance was made through a successful analysis of the thermoelectric data previously obtained for n-type binary and doped Tl–Te solutions. The data were fitted in considerable detail to the equations of conventional transport theory. (W.D.M.)

10143 (SC-CR-67-2709) AN ELASTIC INSTABILITY ANALYSIS OF ORTHOTROPIC OGIVAL SHELLS OF REVOLUTION SUBJECTED TO STATIC AXISYMMETRIC EXTERNAL PRESSURES. Final Report. Priddy, Thomas Glynn (Texas Univ., Austin. Engineering Mechanics Research Lab.). Oct. 1967. Contracts 82-2312; AT(29-1)-789. 112p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

An energy formulation is presented for the elastic stability problem of thin orthotropic shells of revolution subjected to static axisymmetric loading. Parameter variations retained in this formulation permit: eccentricities in shell construction, different effective Poisson's ratios for bending and extensional strains, orthotropic rigidities, and variation of these in the meridional direction of the shells. These construction details are sometimes needed in the analysis of filament wound shells, and applying averaged rigidity assumptions, in the analysis of eccentrically stiffened shells. Approximate solutions are explored for an ogival shell under external pressure loading. A systematic numerical analysis procedure is utilized to accommodate the complicated construction details and to permit various refinements in meridional buckle mode shapes. Two types of assumed edge support, simply supported and fixed, are studied. Routines are included for an analysis of filament wound ogive construction. Circular cylinders, spheres, and cones are limiting cases of an ogive. Published results for these limiting shapes are compared with the numerical results obtained in the present study. Curves which illustrate some of these comparisons, effects of the special geometry, and effects of construction details are presented. (auth)

10144 (SC-DR-67-800) MAC (MULTI-APPLICATION CONTROLLER) PRODUCTION AND QUALITY PROGRAM. Carli, Gino; Stoner, C. L. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 25p. Dep. CFSTI.

The planning and methods used in establishing a production, procurement and quality program for a Multi-Application Controller (MAC) and Digital Recorder are described. (auth)

10145 (SC-DR-67-883) SOLUTIONS TO PROBLEMS OF BENDING OF SYMMETRICALLY AND ASYMMETRICALLY LOADED CIRCULAR CYLINDRICAL SHELLS WITH SIMPLY SUPPORTED EDGES. Johnson, Roy L. Jr. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 31p. Dep. CFSTI.

The solutions to several problems in bending of circular cylindrical shells with simply supported edges due to discontinuous symmetric and asymmetric radial loadings are presented. The method of solution employs a double trigonometric Fourier series to represent the unknown displacements and given loads. The result is a set of algebraic equations for the Fourier series coefficients of the displacements in terms of the loads. These have been solved for several loadings and the results presented. (auth)

10146 (SC-RR-502) MEASURED PULSE STRETCHING IN RADAR RETURN FROM TERRAIN. Edrington, T. S. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-1)-789. 111p. Dep. CFSTI.

A large quantity of data on the character of pulse-radar echoes from terrain is presented in graphical form. Median intensity (power) of return pulses is plotted against time; the stretching effect of terrain targets upon reflected pulses is thereby illustrated. (auth)

10147 (SC-RR-67-599) SUCCESSIVE SUBSTITUTION IN MORSE INFERENCE. Progress Report. McMinn, T. J. (Nevada Univ., Reno. Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 20p. Dep. CFSTI.

In the summer of 1966 Sandia Laboratories initiated a research project on computer implementation of the formal language of A. P. Morse. An important part of this project has been concerned with discovering and algorithmatising extended rules of inference for the purpose of writing proof-check computer programs. Some of the progress made in devising one such extended rule of inference, namely successive substitution, is reported. (auth)

10148 (SC-RR-67-789) ARITHMETIC IN GALOIS FIELDS OF CHARACTERISTIC 2. Morrison, D. R.; Woolsey, R. E. D. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 14p. DTIE.

Algorithms are presented for performing addition, subtraction, multiplication, and division in a Galois field GF (2^n) of characteristic 2. The field is defined by an $(n + 1)$-bit binary word whose bits are the coefficients of an irreducible polynominal of degree n over GF (2). Elements of the field are represented similarly. (auth)

10149 (SC-RR-67-859) MIXTURES OF CHEMICALLY REACTING INVISCID FLUIDS. Wiese, J. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 32p. Dep. CFSTI.

A theory of mixtures of chemically reacting inviscid fluids is presented. The effects of viscosity, heat conduction, and diffusion are omitted for simplicity. A section on reaction kinetics is included. Constitutive equations are presented and restricted by the second law of thermodynamics. To illustrate the theory a mixture of chemically reacting perfect gases was analyzed. A procedure for solving the equations of the theory by numerical methods is outlined. (auth)

10150 (SC-TM-67-798) PROBABILITY DISTRIBUTIONS FOR THE RC-INTEGRATED RANDOM TELEGRAPH SIGNAL. Edrington, T. S. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 11p. DTIE.

The probability density function for the RC-integrated random telegraph signal has been derived by Wonham and Fuller. Complementary distribution functions (for several values of the integrator time constant) obtained by numerical integration of the density functions are tabulated. (auth)

10151 (SC-TM-67-2938) DUAL SPECIFICATIONS IN VIBRATION TESTING. Murfin, Walter B. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 16p. Dep. CFSTI.

A method of specifying vibration test inputs using both force and motion is shown to be superior to specification of either input alone. (auth)

10152 (SC-TM-67-3006) GENERALIZED RADAR-RETURN COMPUTATIONAL TECHNIQUE. Cooper, J. A. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 69p.

Many of the radar-return problems confronting radar designers, including antenna pattern measurement, polarization properties, target modeling, and scattering cross section per unit area are discussed. A computational technique is developed, allowing the practical application of experimental measurements in a programmed solution that is unusually general. (auth)

10153 (TID-4552(Rev.5)) SUBJECT SCOPE OF NUCLEAR SCIENCE ABSTRACTS. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Jan. 1968. 63p. Dep. DTIE Free.

The scope and arrangement of the subject matter of the literature covered in Nuclear Science Abstracts are presented. Ten major fields are identified which contains all the subject diversity of nuclear science and technology. The extent of interest in the chemical elements is shown. An index to the description of the subject scope is included. (B.G.D.)

10154 (TID-23984) FORMULAS FOR CIRCULAR PLATES SUBJECTED TO SYMMETRICAL LOADS AND TEMPERATURES. Heap, James C. (Argonne National Lab., Ill.). Dec. 1966. 302p. Dep. CFSTI.

A collection of formulas for circular plates subjected to symmetrical loads and temperatures is given. Loadings considered include unequal, uniform moments along edges; uniform loads on concentric circles; variable power-term load on concentric annulus; uniform load on concentric annulus; trapezoidal load on concentric annulus; concentrated load at center of plate; force intensity per radius on concentric annulus; constant force per radius squared; and superpositioned cases. Thermal stresses and displacements of circular plates having symmetrical temperature distributions are also included. (F.S.)

10155 (TID-24194) REACTIONS OF HYDROGEN ATOMS WITH SOLID CARBOXYLIC ACIDS. PART A. Taylor, E. D.; Johnsen, R. H. (Florida State Univ., Tallahassee). [1966]. Contract AT(40-1)-2001. 16p. Dep. CFSTI.

Studies were made to determine several aspects of the reaction of hydrogen atoms with glycine. The glycine was placed in the bottom of a quartz tube and the entire system outgassed to at least 2×10^{-5} torr. Then ultrapure hydrogen was admitted in the pressure range 5 to 120 μ and the Whitey valve closed. The quartz tube was then placed in an EPR cavity and continuous scans made during the rest of the experiment in order to determine radical concentrations. No radicals were detected by EPR. It was concluded that the condition of the reaction vessel and tungsten filament is the dominant factor in the pressure changes observed, not the sample. (M.C.G.)

10156 (UCID-15234) CODE DESCRIPTION: SHAZAM I. Watson, James C. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 19, 1967. Contract W-7405-eng-26. 10p. Dep. CFSTI.

This is the first of a series of reports describing the SHAZAM codes used for data reduction at LRL. SHAZAM I is a code which calculates the best value from a series of measurements by using weighting factors proportional to the inverse squares of the probable errors of the measurements. The probable error in the average, a weighted standard deviation from the average, and chi-squared for the distribution are also calculated. (auth)

10157 (UCID-15244) COMPLEX ON THE 3600. Warren, D. T. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 17, 1967. Contract W-7405-eng-48. 47p. Dep. CFSTI.

The computer program COMPLEX, a least squares method for fitting quadratically interpolated tables to a two-dimensional data array, is reorganized for use in the CDC 3600 computer. COMPLEX is used to compute values of a function, such as energy or pressure, as a function of two variables. (W.H.K.)

10158 (UCRL-17768) TRANSPORT PROPERTIES OF CONCENTRATED ELECTROLYTIC SOLUTIONS. Chapman, Thomas W. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1967. Contract W-7405-eng-48. 202p. Dep. CFSTI.

Thesis.

Some problems in the definition, measurement, and correlation of mass-transfer properties in concentrated solutions were investigated. The flux expression used for describing mass transport in electrolytic solutions is inadequate at high concentrations and in multicomponent systems. A set of flux expressions generally applicable are discussed. These equations serve to define the proper number of independent transport properties, which are state properties of a system and which have a more direct fundamental significance than those measured experimentally. To investigate the dependence of these transport properties on concentration and temperature, their values were calculated for the 32 systems for which sufficient data are available. The behavior of the calculated properties is much more systematic than that of the measured properties. The ionic diffusion coefficients defined by the general flux expression were interpreted in terms of the effects of various ions on the structure of water. The concentrated-solution flux equations may also be used to analyze experimental measurements.

Their application demonstrates that a restricted diffusion measurement yields a well-defined differential diffusion coefficient. A restricted diffusion apparatus was developed, which uses Rayleigh interferometry to observe a concentration profile. The method appears to be accurate to 0.2%. It was used to measure the diffusivity of nitric acid in water at 25°C at concentrations up to 3M. The results are consistent with qualitative generalizations drawn from the behavior of the transport properties calculated for other systems. (auth)

10159 (UCRL–50307) OPTICAL PROPERTIES AND ELECTRONIC BAND STRUCTURE OF ZINC: REFLECTANCE AND PHOTOEMISSION STUDIES. Mosteller, Lawson P. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 22, 1967. Contract W-7405-eng-48. 101p. Dep. CFSTI.

Reflectance and photoemission measurements were used to investigate the optical properties and electronic band structure of Zn. The quantum yield, work function, energy distribution, and temperature dependence of photoemission were measured on a single crystal of Zn cleaved in the basal plane. The crystal was cleaved and measurements made at pressures of 10^{-9} torr to ensure surface cleanliness during reflectivity measurements. The reflectometer designed for these measurements is described. The reflectivity for the basal plane was measured for four different angles of incidence in range from 50 to 70°. Reflectance of air-exposed Zn was compared with noncontaminated Zn; air exposure drastically reduced reflectance. Theoretical expressions for the reflectance coefficients for the basal plane were derived in terms of angle of incidence, polarization, and the four optical constants $n_\perp$, $k_\perp$, $n_{||}$, and $k_{||}$. The optical constants $n_\perp$ and $k_\perp$ were determined from the measured reflectance coefficients. These in turn were used to compute $\varepsilon_\perp$, $-\mathrm{Im}(1/\varepsilon_\perp)$, and reflectivity for normal incidence. The optical constants $n_{||}$ and $k_{||}$ are not reported because the reflectivity is not sufficiently sensitive to them to obtain meaningful values. The optical constants are in close agreement with those predicted by the Drude model. The plasma frequency for the lossless case is 9.5 eV, corresponding to an effective electron density of one-half the true valence electron density. The true plasma frequency for Zn, corresponding to the peak in the energy loss function, $-\mathrm{Im}(1/\varepsilon_\perp)$, is 10.1 eV. An improved technique for measuring the energy distribution of photoelectrons was used to investigate the electronic band structure to a depth of 8 eV below the Fermi surface. A weak structure was detectable in the energy distribution, N(E), and was assignable to the initial states below the Fermi level. The quantum yield per incident photon increased with a rise in temperature, with no apparent change in the shape of the energy distribution curves for photon energies below the plasma region. The temperature dependence is attributed to an increase in the probability for indirect transitions that originate from an increase in phonon population. The quantum yield per incident photon rose sharply at the onset of the plasma region, while at the same time the quantum yield per absorbed photon dropped sharply in this same region. The work function for Zn was determined from a Fowler plot to be 3.63 eV. A Monte Carlo analysis of photoemission in Zn indicated a mean free path for electron–electron scattering of about 75 Å for electrons at energies about 5 eV above the Fermi level. (auth)

10160 (AEC-tr–6710) TOXICOLOGY OF THE RARE METALS. Izrael'son, Z. I. (ed.). Translation of Toksikologiya Redkikh Metallov, Gosudarstvennoe Izdatel'stvo, Meditsinskoi Literatury, Moscow, 1963. 224p. (IPST-Cat.–1809). CFSTI. JCL $15.00 fs, $6.95 mf.

Problems of industrial hygiene during the production and use of certain metals, metal alloys, and metal compounds are discussed. Emphasis is placed on the toxicity of inhaled aerosols and dusts to personnel. The metals considered were cadmium, cobalt, copper, barium, molybdenum, nickel, niobium, rare earth metals, tantalum, tellurium, titanium, tungsten, vanadium, zinc, and zirconium. Silicon dusts of various metals are also discussed. (C.H.)

10161 (AEC-tr–6909) WATER DESALINATION PLANTS FOR SEAGOING VESSELS. Kovalenko, V. F.; Lukin, G. Ya.; Rogalev, B. M. Translation of Vodoopresnitel'nye Ustanovki Morskikh Sudov, Izdatel'stvo, Transport, Moscow, 1964. 346p. Dep. CFSTI. JCL $21.00 fs, $9.68 mf.

A review of industrial and laboratory methods of seawater desalination and an evaluation of their applicability to ships are presented. Basic attention is devoted to distillation as the most promising method of shipboard desalination. Measures are considered for improving the engineering and economic features of shipboard evaporators. A description is given of the new evaporator types and designs and of the evaporator plant diagrams that have appeared during the past 10 to 15 years on Soviet and foreign ships. Problems are considered from the theory of evaporators, heat transfer, scale formation, vapor separation and heat calculations. Considerable attention is devoted to combating scale. A new method is described for controlling scale formation. The economy of shipboard seawater desalination is appraised. (auth)

10162 (AEC-tr–6927) DIFFUSION OF CHROMIUM THROUGH ITS OXIDE. Fedorchenko, I. M.; Ermolovich, Yu. B. Translated from Ukr. Khim. Zh., 26: 429-31(1960). 5p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Experimental data on the behavior of chromium diffusing through the oxide Cr_2O_3 was obtained. On the assumption that the limiting solubility of chromium in Cr_2O_3 is caused by the existence of an equilibrium, at a given temperature, concentration of defects in the Cr_2O_3 crystal lattice, coefficients of diffusion of chromium in Cr_2O_3 were calculated and the energy of activation of this process equal to 88,700 kcal/gram-atom was obtained. (auth)

10163 (LA-tr–67-88) FLAME PROPAGATION INTO THE GAP OF SOLID PROPELLANT GRAIN. [PART] I. Godai, T. (National Aerospace Lab., Tokyo (Japan)). Translation of report NAL-tr–91. 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Flame propagation into a narrow gap prepared perpendicular to the prime burning surface of solid propellant grain was investigated experimentally using test specimens of polyester-ammonium perchlorate composite propellant. Results showed that the flame propagates from the original burning surface into a gap when its width is larger than some critical value and vice versa. This means that there is always a critical value of the gap width that is the threshold of propagation and nonpropagation of flame into it. The critical value is primarily a function of the linear burning rate, and the overall mechanism of flame propagation into a gap of solid propellant grain is explained by the quenching theorem. (auth)

10164 (LA-tr–67-110) LIE SERIES AND THEIR APPLICATIONS. CHAPTER 1. GENERAL THEORY OF LIE SERIES. Groebner, Wolfgang. Translated by Cheryl DePoorter (Los Alamos Scientific Lab., N. Mex.), from pp 1-49 of Die Lie-Reihen und ihre Anwendungen. Berlin, Deutscher Verlag der Wissenschaften, 1960. 74p. Dep. CFSTI. JCL $7.60 fs, $2.48 mf.

The definition of a one-dimensional Lie series is developed. Theorems establishing convergence are formulated and proven. Properties of Lie series are derived. An extension of Lie series into multidimensions is then considered. Solutions to autonomous and nonautonomous systems of differential equations, through use of Lie series, are demonstrated. (M.L.S.)

10165 (ORNL-tr–1679) ON THE THERMAL DECOMPOSITION OF CALCIUM SULFATE AT LOW TEMPERATURES. Hedvall, J. A.; Nordengren, Sven; Liljegren, B. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Acta Polytech. Chem., Met. Ser., 4: No. 7, 3-18(1955). 14p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

It was found that calcium sulfate can be decomposed at 1000°C in connection with a reaction with quartz in which the crystallographic transformation of quartz heightened the reactivity. In order to make this effect still more pronounced, NaCl was used. The reaction rate was increased by continuous removal of the decomposition gases. Other methods of increasing the decomposition rate are discussed. (M.C.G.)

10166 (ORNL-tr–1827) ELECTROLYTIC FABRICATION OF VERY FINE HOLES. Nannichi, Ro. Translated for Oak Ridge National Lab., Tenn., from Nippon Kikai Gakkaishi, 64: 1149-57 (Aug. 1961). 28p. Dep. CFSTI. JCL $2.60 fs, $1.04 mf.

The mechanism of electrolytic fabrication of small holes was investigated. The fabrication modes were analyzed, and the characteristics of the electrolytic nozzle used to bring about this fabrication were established. Results obtained with this technique are discussed. It is believed that the electrolytic method for fabricating small holes represents a new and improved technique for the precision fabrication of fine holes. It should find application in fabricating diaphragm plates for optical equipment, parts for various electronic equipment, very fine dies, nozzles for forming chemical fibers, and injection nozzles for internal combustion engines. (auth)

10167 (WAPD-Trans-81) THE PROBLEM OF EQUILIBRIUM OF AN ELASTIC PARALLELEPIPED SUBJECTED TO ASSIGNED LOADS ON ITS BOUNDARIES. Filonenko-Borodich, M. M. Translated by Rosalind Kent for Westinghouse Electric Corp., Bettis Atomic Power Lab., West Mifflin, Pa., from Prikl. Mat. Mekh., 15: 137-48(1951). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The equilibrium of an elastic parallelepiped subjected to assigned loads on its boundaries was analyzed using the variational method of Castigliano. The stress state was assigned to satisfy equations of equilibrium everywhere in the region of the body, satisfy boundary conditions, and to contain a linearly sufficient number of free parameters to make it possible to vary the stress state while maintaining the conditions specified. (F.S.)

10168 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1967. PART 1. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATE, EIGHTY-NINTH CONGRESS, SECOND SESSION ON GENERAL; SPECIAL NUCLEAR MATERIALS; RAW MATERIALS; REACTOR DEVELOPMENT (EXCEPT CIVILIAN POWER AND COOPERATIVE POWER REACTOR CATEGORIES); AND SPACE NUCLEAR SYSTEMS, JANUARY 25, FEBRUARY 15, AND MARCH 4 AND 8, 1966. Washington, D. C., Joint Committee on Atomic Energy, 1966. 600p. GPO.

10169 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1968. PART 3. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, FIRST SESSION ON SPACE NUCLEAR SYSTEMS; RAW MATERIALS; BIOLOGY AND MEDICINE; ISOTOPES DEVELOPMENT; SPECIAL NUCLEAR MATERIALS; TRAINING, EDUCATION, AND INFORMATION; PROGRAM DIRECTION AND ADMINISTRATION; COMMUNITY; PLOWSHARE; SECURITY; WEAPONS; AND GENERAL, FEBRUARY 28, MARCH 2 AND 3, 1967. Washington, D. C., Joint Committee on Atomic Energy, 1967. 518p. GPO $1.75.

Appendix I

JOURNAL LIST

The following list includes 1968 additions to the comprehensive list published in NSA, Volume 22, No. 1, January 15, 1968. In the future, comprehensive lists will be published once each year (in January), and current additions will be cumulated on a monthly basis (in alternate issues) until the next comprehensive list is issued.

The title abbreviations are based on the United States of America Standards Institute's REVISED AND ENLARGED WORD-ABBREVIATION LIST FOR USASI Z39.5–1963 AMERICAN STANDARD FOR PERIODICAL TITLE ABBREVIATIONS. Titles of journals that are scanned regularly for NUCLEAR SCIENCE ABSTRACTS are marked by an asterisk (*). Foreign-language journals identified by a dagger (†) are available in English translation. The original-language title for a translated journal is given in parenthesis after the English title.

- ***Acta Anat. Nippon.***
  - Acta Anatomica Nipponica
    - **see *Kaibogaku Zasshi***
- ***Acta Astron.***
  - Acta Astronomica, Polska Akademia Nauk (formed by merger of Acta Astronomica, Ser. A; Ser. B; and Ser. C) *(Poland)*
- ***Acta Entomol. Bohemoslov.***
  - Acta Entomologica Bohemoslovaca *(Czechoslovakia)*
- ***Acta Med. Iugoslav.***
  - Acta Medica Iugoslavica *(Yugoslavia)*
- ***Acta Pharm. Hung.***
  - Acta Pharmaceutica Hungarica *(Hungary)*
- ***Acta Phys. Chem.***
  - *Acta Physica et Chemica *(Hungary)*
- ***Acta Polytech., Chem. Met. Ser.***
  - Acta Polytechnica, Chemistry including Metallurgy Series *(Sweden)*
- ***Agr. Hokkaido***
  - Agriculture in Hokkaido
    - **see *Hokuno***
- ***Agr. Res. (New Delhi)***
  - Agricultural Research (New Delhi) *(India)*
- ***Air Water Pollut.***
  - *Air and Water Pollution (formerly International Journal of Air Water Pollution) *(U. S.–England)*
- ***Ala. J. Med. Sci.***
  - Alabama Journal of Medical Sciences, The *(U. S.)*
- ***Ann. Bot. Fenn.***
  - Annales Botanici Fennici *(Finland)*
- ***Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol.***
  - *Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominatae, Sectio Geologica *(Hungary)*
- ***An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.***
  - Analele Universitatii Bucuresti, Seria Stiintele Naturii, Fizica *(Romania)*
- ***Arch. Jap. Chir.***
  - Archiv fuer Japanische Chirurgie
    - **see *Nippon Geka Hokan***
- ***Astrofizika***
  - Astrofizika *(Armenian S.S.R.)*
- ***Astrophys. Lett.***
  - *Astrophysical Letters *(Scotland)*
- ***At. Absorption Newslett.***
  - Atomic Absorption Newsletter *(U. S.)*
- ***At. Energy (China)***
  - Atomic Energy (China)
    - **see *Yuan Tzu Neng***
- ***At. Energy Law J.***
  - Atomic Energy Law Journal *(U. S.)*
- ***Berg- Huettenmaenn. Monatsh. Montan. Hochsch. Leoben***
  - Berg- und Huettenmaennische Monatschefte der Montanistischen Hochschule in Leoben *(West Germany)*
- ***Blech***
  - Blech *(West Germany)*
- ***Bodenkultur***
  - Bodenkultur, Die *(Austria)*
- ***Boll. Zool.***
  - Bollettino di Zoologia. Pubblicato dall'Unione Zoologica Italiana *(Italy)*
- ***Bull. Astron.***
  - Bulletin Astronomique *(France)*
- ***Bull. Belgicatom***
  - Bulletin Belgicatom (formerly Belgicatom, Association Belge pour le Developpement Paficique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*
- ***Bull. Fac. Eng., Hiroshima Univ.***
  - Bulletin of the Faculty of Engineering, Hiroshima University
    - **see *Hiroshima Daigaku Kogakubu Kenkyu Hokoku***
- ***Bull. Fac. Sci. Eng., Chuo Univ.***
  - Bulletin of the Faculty of Science and Engineering, Chuo University
    - **see *Chuo Daigaku Rikogakubu Kiyo***
- ***Bull. Inst. Geophys., Nat. Cent. Univ.***
  - *Bulletin of the Institute of Geophysics, National Central University *(China (Taiwan))*
- ***Bull. Inst. Space Aeronaut. Sci., Univ. Tokyo***
  - Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo
    - **see *Tokyo Daigaku Uchu Koku Kenkyusho Hokoku***
- ***Bull. Kyoto Educ. Univ., Ser. B***
  - Bulletin of the Kyoto Educational University, Series B. Mathematics and Natural Science *(Japan)*
- ***Bull. Res. Inst. Miner. Dressing Met., Tohoku Univ.***
  - Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University
    - **see *Tohoku Daigaku Senko Seiren Kenkyusho Iho***
- ***Bus. Week***
  - Business Week *(U. S.)*
- ***Cah. Ing. Agron.***
  - Cahiers des Ingenieurs Agronomes *(France)*
- ***Calcified Tissue Res.***
  - Calcified Tissue Research *(West Germany)*
- ***Can. J. Psychol.***
  - Canadian Journal of Psychology *(Canada)*
- ***Can. Nurse***
  - Canadian Nurse *(Canada)*
- ***Chesapeake Sci.***
  - Chesapeake Science *(U. S.)*
- ***Chim. Ind., Genie Chim.***
  - Chimie et Industrie, Genie Chimique (formed by the merger of Chimie et Industrie (Paris) and Genie Chimique (Paris)) *(France)*
- ***Chin. Anim. Husb. Vet. Med.***
  - Chinese Animal Husbandry and Veterinary Medicine
    - **see *Chung Kuo Hsu Mu Shou I***
- ***Chung Kuo Hsu Mu Shou I***
  - Chung Kuo Hsu Mu Shou I (Chinese Animal Husbandry and Veterinary Medicine) *(China)*
- ***Chuo Daigaku Rikogakubu Kiyo***
  - Chuo Daigaku Rikogakubu Kiyo (Bulletin of the Faculty of Science and Engineering, Chuo University) *(Japan)*
- ***Coal Age***
  - Coal Age *(U. S.)*

Cobalt
Cobalt *(France)*
Commer. Fish. Rev.
Commercial Fisheries Review *(U. S.)*
Comput. Biomed. Res.
Computers and Biomedical Research *(U. S.)*
Coord. Chem. Rev.
Coordination Chemistry Reviews *(Netherlands)*
Curr. Mod. Biol.
Currents in Modern Biology *(Netherlands)*
Denki Shikenjo Kenkyu Hokoku
Denki Shikenjo Kenkyu Hokoku (Researches of the Electrotechnical Laboratory) *(Japan)*
Desalination
Desalination *(Netherlands)*
Eiyo To Shokuryo
Eiyo To Shokuryo (Journal of Japanese Society of Food and Nutrition) *(Japan)*
Elec. World (Shanghai)
Electrical World (Shanghai)
see Tien Shih Chieh
Elektromedizin
Elektromedizin und Ihre Grezgebiete *(Germany)*
Elektrotekhnika
Elektrotekhnika *(U.S.S.R.)*
Engei Gakkai Zasshi
Engei Gakkai Zasshi (Journal of the Japanese Society for Horticultural Science) *(Japan)*
Entropie
Entropie *(France)*
Ergonomics
Ergonomics *(England)*
Farm, Ranch, Home Quart.
Farm, Ranch and Home Quarterly *(U. S.)*
Fiz. Chastits Vys. Energ., Akad. Nauk Gruz. SSSR, Inst. Fiz.
Fizika Chastits Vysokikh Energii, Akademiya Nauk Gruzinskoi SSR, Institut Fiziki *(Georgian S.S.R.)*
Fiziol. Norm. Patol. (Bucharest)
Fiziologia Normala si Patologica (Bucharest) *(Romania)*
Fiz. Tekh. Poluprov.
Fizika i Tekhnika Poluprovodnikov *(U.S.S.R.)*
Flame Notes, Beckman
Flame Notes, Beckman *(U. S.)*
Folia Haematol. (Leipzig)
Folia Haematologia (Leipzig) *(East Germany)*
***Folia Med.* Cracov.**
Folia Medica Cracoviensia *(Poland)*
Forest. Abstr.
Forestry Abstracts *(England)*
Fortschr. Zool.
Fortschritte de Zoologie *(West Germany)*
Freiberg. Forschungsh., B
Freiberger Forschungshefte, Reihe B *(East Germany)*
Fukushima Daigaku Gakugei Gakubu Rika Hokoku
Fukushima Daigaku Gakugei Gakubu Rika Hokoku (The Science Reports of the Faculty of Arts and Science, Fukushima University) *(Japan)*
Geofys. Sb.
Geofysikalni Sbornik *(Czechoslovakia)*
Geol. Geofiz.
Geologiya i Geofizika *(U.S.S.R.)*
Haikan Gijutsu
Haikan Gijutsu (The Piping Engineering) *(Japan)*
Harper Hosp. Bull.
Harper Hospital Bulletin *(U. S.)*
Health Lab. Sci.
Health Laboratory Science *(U. S.)*
Hemel Dampkring
Hemel en Dampkring *(Belgium)*
Hiroshima Daigaku Kogakubu Kenkyu Hokoku
Hiroshima Daigaku Kogakubu Kenkyu Hokoku (Bulletin of the Faculty of Engineering, Hiroshima University) *(Japan)*
Hoken Butsuri
Hoken Butsuri (Journal of Japan Health Physics Society) *(Japan)*
Hokuno
Hokuno (Agriculture in Hokkaido) *(Japan)*
Honvedorvos
Honvedorvos *(Hungary)*
Hyogo Noka Daigaku Kiyo
Hyogo Noka Daigaku Kiyo (Memoirs of the Hyogo University of Agriculture) *(Japan)*
Indian J. Agr. Sci.
Indian Journal of Agricultural Science, The *(India)*
Indian J. Appl. Chem.
Indian Journal of Applied Chemistry *(India)*
Indian J. Cancer
Indian Journal of Cancer *(India)*
Indian J. Occup. Health
Indian Journal of Occupational Health *(India)*
Ind. Water Eng.
Industrial Water Engineering *(U. S.)*
Int. J. Neurol.
International Journal of Neurology *(U. S.)*
Int. Rev. Gesam. Hydrobiol.
Internationale Revue der Gesamten Hydrobiologie *(East Germany)*
Int. Surg.
International Surgery *(U. S.)*
Izobret., Prom. Obraztsy, Tovarnye Znaki
Izobreteniya, Promyshlennye Obraztsy, Tovarnye Znaki *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Geol.
Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya *(U.S.S.R.)*
Jap. J. Pharm. Chem.
Japanese Journal of Pharmacy and Chemistry
see Yakugaku Kenkyu
Jap. J. Zootech. Sci.
Japanese Journal of Zootechnical Science
see Nippon Chikusangaku Kaiho
JARE Sci. Rep., Spec. Issue
JARE Scientific Reports, Special Issue *(Japan)*
J. Aust. Ceram. Soc.
Journal of the Australian Ceramic Society *(Australia)*
J. Balneol. Soc. Jap.
Journal of the Balneological Society of Japan
see Onsen Kagaku
J. Forensic Med.
Journal of Forensic Medicine *(South Africa)*
J. Indian Soc. Soil Sci.
Journal of the Indian Society of Soil Science *(India)*
J. Inst. Safety High Pressure Gas Eng.
Journal of the Inst. of Safety of High Pressure Gas Engineering
see Koatsu Gasu
J. Inst. Telecommun. Eng.
Journal of the Institution of Telecommunication Engineers *(India)*
J. Irrig. Drain. Div., Amer. Soc. Civil Eng.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers *(U. S.)*
J. Jap. Health Phys. Soc.
Journal of Japan Health Physics Society
see Hoken Butsuri
J. Jap. Soc. Food Nutr.
Journal of Japanese Society of Food and Nutrition
see Eiyo To Shokuryo
J. Jap. Soc. Hort. Sci.
Journal of the Japanese Society for Horticultural Science
see Engei Gakkai Zasshi
J. Jap. Tech. Ass. Pulp Pap. Ind.
Journal of the Japanese Technical Association of Pulp and Paper Industry
see Kami Pa Gikyoshi
J. Jap. Wood Res. Soc.
Journal of the Japan Wood Research Society
see Mokuzai Gakkaishi
J. Macromol. Sci., Part A
Journal of Macromolecular Science, Part A. Chemistry (supersedes Journal of Macromolecular Chemistry) *(U. S.)*
J. Nagasaki Med. Ass., Suppl.
Journal of the Nagasaki Medical Association, Supplement
see Nagasaki Igakkai Zasshi, Suppl.
J. Phys. Chem. Solids, Suppl.
*Journal of Physics and Chemistry of Solids, Supplement *(England)*
J. Radiol. Phys. Ther., Univ. Kanazawa
Journal of Radiology and Physical Therapy, University of Kanazawa, The
see Kanazawa Irigaku Sosho
J. Soc. Eng. Miner. Springs, Jap.
Journal of the Society of Engineers for Mineral Springs, Japan
see Onsen Kogakkaishi
J. Soc. Fiber Sci. Technol., Jap.
Journal of the Society of Fiber Science and Technology, Japan
see Sen'i Gakkaishi
J. Soc. Rubber Ind., Jap.
Journal of the Society of Rubber Industry, Japan
see Nippon Gomu Kyokaishi
Kagaku Keisatsu Kenkyusho Hokoku
Kagaku Keisatsu Kenkyusho Hokoku (Reports of the National Research Inst. of Police Science) *(Japan)*

Kagoshima Daigaku Suisangakubu Kiyo
Kagoshima Daigaku Suisangakubu Kiyo (Memoirs of the Faculty of Fisheries, Kagoshima University) ***(Japan)***
Kaibogaku Zasshi
Kaibogaku Zasshi (Acta Anatomica Nipponica) ***(Japan)***
Kami Pa Gikyoshi
Kami Pa Gikyoshi (Journal of the Japanese Technical Association of Pulp and Paper Industry) ***(Japan)***
Kanazawa Irigaku Sosho
Kanazawa Irigaku Sosho (Journal of Radiology and Physical Therapy, University of Kanazawa, The) ***(Japan)***
Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung ***(West Germany)***
Koatsu Gasu
Koatsu Gasu (Journal of the Inst. of Safety of High Pressure Gas Engineering) ***(Japan)***
Kobe Kogyo Giho
Kobe Kogyo Giho (Kobe Kogyo Technical Report) ***(Japan)***
Kobe Kogyo Tech. Rep.
Kobe Kogyo Technical Report
see Kobe Kogyo Giho
Kosm. Biol. Med.
Kosmicheskaya Biologiya i Meditsina ***(U.S.S.R.)***
Kovove Mater.
Kovove Materialy ***(Czechoslovakia)***
Kumamoto Daigaku Kogakubu Kenkyu Hokoku
Kumamoto Daigaku Kogakubu Kenkyu Hokoku (Technical Reports of the Kumamoto University) ***(Japan)***
Kumamoto Daigaku Kyoikugakubu Kiyo
Kumamoto Daigaku Kyoikugakubu Kiyo (Memoirs of the Faculty of Education, Kumamoto University) ***(Japan)***
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku (Report of the Training Inst. for Engineering Teachers, Kyoto University) ***(Japan)***
Kyushu Daigaku Kogaku Shuho
Kyushu Daigaku Kogaku Shuho (Technology Reports of the Kyushu University) ***(Japan)***
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku (The Reports of the Research Inst. of Science and Industry, Kyushu University) ***(Japan)***
Landbouwtijdschrift
Landbouwtijdschrift ***(Belgium)***
Lebensversicherungsmedizin
Lebensversicherungsmedizin ***(West Germany)***
Lipids
Lipids ***(U. S.)***
Mach. Shop Eng. Mfg.
Machine Shop and Engineering Manufacture ***(England)***
Mater. Res. Bull.
Materials Research Bulletin ***(U. S.)***
Mem. Fac. Educ., Kumamoto Univ.
Memoirs of the Faculty of Education, Kumamoto University
see Kumamoto Daigaku Kyoikugakubu Kiyo
Mem. Fac. Fish., Kagoshima Univ.
Memoirs of the Faculty of Fisheries, Kagoshima University
see Kagoshima Daigaku Suisangakubu Kiyo
Mem. Hyogo Univ. Agr.
Memoirs of the Hyogo University of Agriculture
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Meres Automat.
Meres es Automatika ***(Hungary)***
Metabolism
*Metabolism: Clinical and Experimental ***(U. S.)***
Metal Sci. Heat Treat. (USSR) (Engl. Transl.)
Metal Science and Heat Treatment (USSR) (English Translation of Metallovedenie i Termicheskaya Obrabotka Metallov) ***(U. S.)***
Met. Rev. (Publ. in Metals Mater.)
Metallurgical Reviews (Published in Metals and Materials) ***(England)***
Mod. Packag.
Modern Packaging ***(U. S.)***
Mokuzai Gakkaishi
Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) ***(Japan)***
Mol. Biol.
*Molekulyarnaya Biologiya ***(U.S.S.R.)***
Monit. Zool. Ital., Suppl.
Monitore Zoologico Italiano, Supplemento ***(Italy)***
Montes
Montes ***(Spain)***
Nagasaki Igakkai Zasshi, Suppl.
Nagasaki Igakkai Zasshi, Supplement (Journal of the Nagasaki Medical Association, Supplement) ***(Japan)***
Nauch. Zap. Inst. Mashinoved. Avtomat., Akad. Nauk Ukr. SSR, Ser. Mashinoved.
Nauchnye Zapiski Instituta Mashinovedeniya i Avtomatiki, Akademiya Nauk Ukraninskoi SSR, Seriya Mashinovedeniya ***(Ukrainian S.S.R.)***
Neth. J. Sea Res.
Netherlands Journal of Sea Research ***(Netherlands)***
Neues Jahrb. Mineral., Monatsh.
Neues Jahrbuch fuer Mineralogie, Monatshefte ***(West Germany)***
Nippon Byori Gakkai Kaishi
Nippon Byori Gakkai Kaishi (Transactiones Societatis Pathologicae Japonicae) ***(Japan)***
Nippon Chikusangaku Kaiho
Nippon Chikusangaku Kaiho (Japanese Journal of Zootechnical Science) ***(Japan)***
Nippon Geka Hokan
Nippon Geka Hokan (Archiv fuer Japanische Chirurgie) ***(Japan)***
Nippon Gomu Kyokaishi
Nippon Gomu Kyokaishi (Journal of the Society of Rubber Industry, Japan) ***(Japan)***
Nippon Sakumotsu Gakkai Kiji
Nippon Sakumotsu Gakkai Kiji (Proceedings of the Crop Science Society of Japan) ***(Japan)***
Nisshin Seiko Giho
Nisshin Seiko Giho (Technical Report of Nisshin Steel Co., Ltd.) ***(Japan)***
N. Z. Sci. Rev.
New Zealand Science Review ***(New Zealand)***
Oceanogr. Mag.
Oceanographical Magazine, The ***(Japan)***
Okayama Daigaku Onsen Kenkyusho Hokoku
Okayama Daigaku Onsen Kenkyusho Hokoku (Papers of the Inst. for Thermal Spring Research, Okayama University) ***(Japan)***
Onde Elec., Suppl.
*Onde Electrique, L, Supplement ***(France)***
Onsen Kagaku
Onsen Kagaku (Journal of the Balneological Society of Japan) ***(Japan)***
Onsen Kogakkaishi
Onsen Kogakkaishi (Journal of the Society of Engineers for Mineral Springs, Japan) ***(Japan)***
Opt.-Mekh. Prom.
Optiko-Mekhanicheskaya Promyshlennost ***(U.S.S.R.)***
Osaka Furitsu Kogyo Shoreikan Hokoku
Osaka Furitsu Kogyo Shoreikan Hokoku (Reports of Industrial Research Inst., Osaka Prefecture) ***(Japan)***
Pap. Inst. Thermal Spring Res., Okayama Univ.
Papers of the Inst. for Thermal Spring Research, Okayama University
see Okayama Daigaku Onsen Kenkyusho Hokoku
Phys. Earth Planet. Interiors
*Physics of the Earth and Planetary Interiors ***(Netherlands)***
Piping Eng.
Piping Engineering, The
see Haikan Gijutsu
Plant Breed. Abstr.
*Plant Breeding Abstracts ***(England)***
Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Farm.
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Farmaceutycznej ***(Poland)***
Praxis (Bern)
Praxis (Bern) ***(Switzerland)***
Proc. Amer. Soc. Hort. Sci.
Proceedings of the American Society for Horticultural Science ***(U. S.)***
Proc. Crop Sci. Soc. Jap.
Proceedings of the Crop Science Society of Japan
see Nippon Sakumotsu Gakkai Kiji
Proc. Indian Acad. Sci., Sect. B
Proceedings of the Indian Academy of Sciences, Section B ***(India)***
Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.)
*Proceedings (Trudy) of the P. N. Lebedev Physics Institute (USSR) (English Translation of Trudy Fizicheskogo Instituta imeni P. N. Lebedeva, Akademiya Nauk SSSR) ***(U. S.)***
Progr. Ind. Microbiol.
Progress in Industrial Microbiology ***(U. S.–England)***
Queensland Govt. Mining J.
Queensland Government Mining Journal ***(Australia)***
Radiobiol. Biol. Mol.
Radiobiologia si Biologia Moleculara ***(Romania)***
Reactor Fuel-Process. Technol.
*Reactor and Fuel-Processing Technology (A Quarterly Technical Progress Review) (formerly Power Reactor Technology and

Reactor Fuel Processing) *(U. S.)*

Rec. Trav. Bot. Neer.

Recueil des Travaux Botaniques Neerlandais *(Netherlands)*

Rep. Fac. Sci., Shizuoka Univ.

Reports of Faculty of Science, Shizuoka University *(Japan)*

Rep. Fire Res. Inst. Jap.

Report of Fire Research Inst. of Japan

see Shobo Kenkyusho Hokoku

Rep. Ind. Res. Inst., Osaka Prefect.

Reports of Industrial Research Inst., Osaka Prefecture

see Osaka Furitsu Kogyo Shoreikan Hokoku

Rep. Nat. Res. Inst. Police Sci.

Reports of the National Research Inst. of Police Science

see Kagaku Keisatsu Kenkyusho Hokoku

Rep. Res. Inst. Ind. Safety

Reports of the Research Inst. of Industrial Safety

see Sangyo Anzen Kenkyusho Hokoku

Rep. Res. Inst. Sci. Ind., Kyushu Univ.

Reports of the Research Inst. of Science and Industry, Kyushu University

see Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku

Rep. Tokyo-to Lab. Med. Sci.

Report of Tokyo-to Lab. for Medical Sciences

see Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku

Rep. Train. Inst. Eng. Teach., Kyoto Univ.

Report of the Training Inst. for Engineering Teachers, Kyoto University

see Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku

Res. Electrotech. Lab.

Researches of the Electrotechnical Laboratory

see Denki Shikenjo Kenkyu Hokoku

Rev. Brasil. Quim. (Sao Paulo)

*Revista Brasileria de Quimica *(Brazil)*

Rev. Elec.

Revista Electricidade *(Portugal)*

Rev. Fr. Elec.

*Revue Francaise de l' Electricite *(France)*

Rev. Interamer. Radiol.

Revista Interamericana de Radiologia *(Peru)*

Rev. Roum. Sci. Tech., Ser. Mecan. Appl.

Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee *(Romania)*

Rev. Zooteh. Med. Vet.

Revista de Zootehnic si Medicina Veterinara *(Romania)*

Roy. Observ. Bull.

Royal Observatory Bulletins *(England)*

Roy. Soc. Health J.

Royal Society of Health Journal *(England)*

RUM, Rev. Universelle Mines

RUM, Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l' Industrie (formerly Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie) *(Belgium)*

Samoletostr. Tekh. Vozdush. Flota

Samoletostroenie i Tekhnika Vozdushnogo Flota *(U.S.S.R.)*

Sangyo Anzen Kenkyusho Hokoku

Sangyo Anzen Kenkyusho Hokoku (Reports of the Research Inst. of Industrial Safety) *(Japan)*

Scand. J. Clin. Lab. Invest., Suppl.

Scandinavian Journal of Clinical and Laboratory Investigation, Supplement *(Sweden)*

Sci. Ind. Spatiales

Sciences et Industries Spatiales *(Switzerland)*

Sci. News (Wash., D. C.)

Science News (Washington, D. C.) *(U. S.)*

Sci. Rep., Coll. Gen. Educ., Osaka Univ.

Science Report, College of General Education, Osaka University *(Japan)*

Sci. Rep. Niigata Univ., Ser. B

Science Reports of Niigata University, Series B. Physics *(Japan)*

Scr. Met.

Scripta Metallurgica *(U. S.)*

Seminars Hematol.

*Seminars in Hematology *(U. S.)*

Seminars Roentgenol.

Seminars in Roentgenology *(U. S.)*

Sen'i Gakkaishi

Sen'i Gakkaishi (Journal of the Society of Fiber Science and Technology, Japan) *(Japan)*

Ser. Haematol.

Series Haematologica (Supplements Scandinavia Journal of Haematology) *(Denmark)*

Shobo Kenkyusho Hokoku

Shobo Kenkyusho Hokoku (Report of Fire Research Inst. of Japan) *(Japan)*

Slaboproudy Obz.

Slaboproudy Obzor *(Czechoslovakia)*

Sov. Antarct. Exped. Inform. Bull.

Soviet Antarctic Expedition Information Bulletin (English Translation of Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii) *(U. S.)*

Stud. Cercet. Endocrinol.

Studii si Cercetari de Endocrinologie *(Romania)*

Stud. Cercet. Energ. Electroteh.

Studii si Cercetari de Energetica si Electrotehnica *(Romania)*

Svetsaren Engl.

Svetsaren in English *(Sweden)*

Technol. Rep. Kyushu Univ.

Technology Reports of the Kyushu University

see Kyushu Daigaku Kogaku Shuho

Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A

Technical Report of ISSP (Inst. for Solid State Physics), Series A *(Japan)*

Tech. Rep. Kumamoto Univ.

Technical Reports of the Kumamoto University

see Kumamoto Daigaku Kogakubu Kenkyu Hokoku

Tech. Rep. Nisshin Steel Co., Ltd.

Technical Report of Nisshin Steel Co., Ltd.

see Nisshin Seiko Giho

Terapia (Milan)

Terapia (Milan) *(Italy)*

Tien Shih Chieh

Tien Shih Chieh (Electrical World) *(China)*

Tohoku Daigaku Senko Seiren Kenkyusho Iho

Tohoku Daigaku Senko Seiren Kenkyusho Iho (Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University) *(Japan)*

Tokyo Daigaku Uchu Koku Kenkyusho Hokoku

Tokyo Daigaku Uchu Kenkyusho Hokoku (Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo) *(Japan)*

Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku

Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku (Report of Tokyo-to Lab. for Medical Sciences) *(Japan)*

Trans. Amer. Ophthalmol. Soc.

Transactions of the American Ophthalmological Society *(Canada)*

Trans. Soc. Pathol. Jap.

Transactiones Societatis Pathologicae Japonicae

see Nippon Byori Gakkai Keishi

Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial

Trudy Instituta Biologii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr., Mosk. Aviats. Tekhnol. Inst.

Trudy, Moskovskii Aviatsionnyi Tekhnologicheskii Institut *(U.S.S.R.)*

Tr. Mosk. Vet. Akad.

Trudy Moskovskoi Veterinarnoi Akademii *(U.S.S.R.)*

Tumor Res.

Tumor Research *(Japan)*

T Z Prakt. Metallbearb.

T Z fuer Praktische Metallbearbeitung *(West Germany)*

Vector (Baltimore)

Vector (Baltimore) *(U. S.)*

Vestn. Cesk. Spolecnosti Zool.

Vestnik Ceskoslovenske Spolecnosti Zoologicke *(Czechoslovakia)*

Volt, Elec. Trade Mon.

Volt, Electrical Trade Monthly *(Japan)*

Vop. Eksp. Klin. Radiol., Khar'kov. Inst. Med. Radiol.

Voprosy Eksperimental'noi i Klinicheskoi Radiologii, Khar'kovskii Institut Meditsinskoi Radiologii *(Ukrainian S.S.R.)*

Water Res.

Water Research (supersedes in part Air and Water Pollution) *(England)*

Water Waste Treat.

Water and Waste Treatment *(England)*

Weld. Res. Counc. Bull.

Welding Research Council Bulletin *(U. S.)*

Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturwiss. Reihe

Wissenschaftliche Zeitschrfit der Ernst-Moritz-Arndt-Universitaet Greifswald, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*

Yadern. Priborostr., Nauch.-Tekh. Sb.

Yadernoe Priborostroenie, Nauchno-Tekhnicheskii Sbornik *(U.S.S.R.)*

Yakugaku Kenkyu

Yakugaku Kenkyu (Japanese Journal of Pharmacy and Chemistry) *(Japan)*

Yuan Tzu Neng

Yuan Tzu Neng (Atomic Energy) *(China)*

Z. Math. Phys.

Zeitschrift fuer Mathematik und Physik *(East Germany)*

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NOTICE

Title pages for Volume 21, Numbers 19–24 and Volume 22, Numbers 1–6, are included at the back of this issue for use in binding those issues.

CORRECTIONS

NSA Vol. 20, No. 15, Abst. No. 27935, line 3 should read: Rusakov, S. V.; Tamm, E. I.; Tatarinskaja, L. S.; Shareiko,

NSA Vol. 21, No. 5, Abst. No. 6299, line 1 should read: SPARK DETECTOR SHOWER PARTICLE RECORDING

NSA Vol. 21, No. 20, Abst. No. 38378, line 1 should read: (USNRDL-TRC-67-25) RADIOACTIVE DISINTEGRA-

NSA Vol. 21, No. 20, Abst. No. 38742, lines 1, 2 and 3 should read: (EIR-100) I. HETEROGENEOUS THEORY OF FINITE REFLECTED LATTICES. Auerbach, T. (Eidgenoessisches Institut

NSA Vol. 21, No. 16, Abst. No. 28335, line 1 should read: (AED-C-04-27) BIBLIOGRAPHIEN ZUR KERN-

NSA Vol. 21, No. 16, Abst. No. 28519, lines 6 and 7 should read: From Symposium on Biological Interpretation of Dose from Acceleration Produced Radiation, Berkeley, Calif.

NSA Vol. 21, No. 16, Abst. No. 29947, line 4 should read: 1249-54(Apr. 20, 1967). (ORNL-P-1904)

NSA Vol. 22, No. 4, Abst. No. 7353, line 1 should read: (SU-DMS-68-T-9) ELECTRON RADIATION DAMAGE